USING CHARTS AND GRAPHS

1000 IDEAS FOR VISUAL PERSUASION

JAN V. WHITE

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By the same author:

Mastering Graphics
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Word-and-picture communication for editors and designers

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Common problems, realistic solutions

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Inventive techniques for designing printed pages

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A miscellany of practical fundamentals

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Recognizing the debt of gratitude an author owes the supporting team is a double pleasure: 1) it feels good to give credit where credit is due, and 2) it means that you're coming to the end of the project. It seems that a year's effort is nearing that blessed due date more or less on schedule and a minute of retrospection is justified at last. If you count second editions, which is only fair, I've been at this point nine times now, and Earth hath naught to show more fair than this moment of blessed release from the pressure of getting on with it. (A trade secret: it is at this moment also that any sensible adult promises never under any circumstances to shove his or her head in that lion's mouth again. Unless . . .) So bear with me while I wallow in self-indulgence.

More than a quarter century ago, when my friend Ron V. Taylor and I were gainfully employed by TIME Inc., I was startled by a question he threw at me: "How many kinds of frames are there?" On the surface of it, that seems ridiculous: obviously, an infinite number, as many as one can dream up, till one gets bored with inventing new combinations. Aah, but you have to *have* elements in order to be able to combine them. Once you have those, you must, of necessity, classify and organize, or you'll go crazy making random combinations. That realization —that it might be useful to do some of that classifying —was the start of my book-making. I discovered that methodical arranging of a welter of apparently unrelated facts into structured systems not only cleared my thinking, but also seemed to fill a need for others. So, Ron, thanks.

Gene Zelazny, Director of Visual Communications at McKinsey & Co., management consultants, who is also an old friend, was another source of challenge: He made me think about the need to illustrate the meaning of statistics, not merely their quantifiable amounts. That lunch resulted indirectly but inevitably in the exploration of a symbol and its interpretation, illustrated by the arrows in chapter 10. That was a delight to do, sitting under a palm tree in the Caribbean, doodling a vacation away . . . IRS please note: it was indeed work!

After the first draft of the manuscript was done, I realized, to my horror, that I was facing the drawing of more than 900 illustrations. When you're dealing with what is, essentially, visual material, you have to show what you're talking about, especially if you're trying to classify the visible options. My son, Alexander, who teaches at Kent State University, happened to be home in Westport for Thanksgiving just at that time and suggested a brilliant idea: Since his students in the Basic Studio Skills course need subjects on which to practice drawing in ink, why not have them draw a few? Knowing that the fruits of their labors will be published will make their exercise more interesting (and they'll learn more by trying harder); and it'll save my having to do what turned out to be 225 first-rate, professional quality drawings. In fact, if you look at chapters 3, 6, and 9, you can tell the difference between the good ones (done by them with care, time, and patience) and the others (done by me with the old pro's resentment that it's all taking too damn much time). They are credited individually alongside each drawing —that's the least I can do to express my appreciation —and the full roster follows:

Margaret Bowe, Vance Carter, Steve Chapo, Sally Chessnut, Stephanie Chovan, Tom Churak, John Cooperrider, Colleene Daugharty, David Derr, Jill Eberly, Terry Edman, Julie Erwin, Tim Greene, Lisa Hermelin, Joanne Kim, Eric Klosky, Linda Liebermann, Brian Longacre, Michele Lyden, Tom Macko, Ellen Manchook, Barb Marinelli, Pete Moran, Beth Muha, Mike Perushek, Mara Rabants, David Racek, Kim Radomsky, Laura Ress, Tama Ripley, Dean Rosson, Frank Sarnicola, Zach Safos, Bob Schaefer, Diana Scott, Perry Sears, Linda Skinner, Jim Skrovan, John Stanko, Rick Stermole, Diana Stoddard, Patti Tate, Debbie Thompson, Chip Valleriano, Larry Wascovich, Roberta Wendel, Wendy Williams, Jill Zell, Caroline Zobeck.

Back to that first draft of the manuscript: With joy and relief, I submitted it to my editor, Betty Sun, for what I fantasized would be a bit of superficial word-editing, fixing the commas here and there, and a word of praise for turning it all in on time. Instead, I got the whole package back, with an explanation why a complete rewrite was justified. Calming down took several weeks; the rewrite took longer. She was right —she always is —and she has no idea how grateful I am, in spite of what she put me through. Iris Topel is charged with seeing to every detail in the book being right, consistent, and logical: Cross-references must be correct, the title names in the table of contents agree with those on the pages themselves, numbers in charts must add up to 100 if you're doing percentages . . . that sort of thing. She has the kind of mind and caring that makes the author look good. Just like Helen Einhorn does in her sphere, the production of the book as a physical product. To them both, my thanks.

Since the acknowledgments are the officially sanctioned place where the author can be personal instead of dignified and pontificatorial, it is the right place to mention the substructure that holds his whole fragile professional edifice together. Since this is a visual book, here they all are. Names are just labels. These are the people whom I love and am proud of, and to whom I dedicate the book:

Westport, CT.

■ What a pity that math was taught to me as such an isolated, self-contained subject in school years ago. It was an unmitigated bore, a discipline whose concepts were intransigent and whose object was to parrot the sequences leading to results—QED. What a revelation it was to watch the same subject taught to my children as a form of *language!* Of course, an equation is a kind of sentence. Its form is rather peculiar, using symbols instead of words, yet it is a clear form of communication nonetheless. It is a different form of tongue. Had I realized this, back then, perhaps I might have been less petrified by its abstractions.

Just as mathematical expressions are a language, graphics, too, are a form of communication. Charts, graphs, diagrams, and tables are all statements combining several thoughts into a related format. Just as language is composed of infinitely arrangeable words, so is its graphic counterpart. Your thoughts—your message—make you choose words and their arrangement when you speak. You may choose to say it simply, embroider it with verbal embellishment, symbolize it in poetic form, or even put it in Latin if you think that will communicate best. And so it is with graphics. You can arrange a collection of statistics in a visual format that corresponds to a simple statement, a flowery rodomontade, a poem, or something with a foreign flavor to it. You can even tell lies if you want to.

This
book
is
about
a
language

Obviously, it looks like a technical book as you flip the pages, but the true purpose of all its specialized technicalities is universal: to help you make yourself understood by visual means. That way you can tell your story with pictures and have your audience respond to its meaning, get excited by it, perhaps even remember it better because of the way you "said" it. Isn't that a language?

You must have three factors under control to communicate effectively this way.

1. You must have clear understanding of what you are trying to say. That requires more than just correct statistical data, which is clearly an essential prerequisite; it also means that you must have an understanding of the *significance* of the numbers. This you must know in order to pick the most lucid visual technique and emphasize those aspects of the diagram that will benefit from such emphasis. In order to lodge the message in the viewer's mind most effectively, you yourself must be unambiguous in your statement.

2. You must know your audience so that the techniques you choose are geared to its needs and its capacity for understanding. You have to have this rapport before you can speak the same language as your listeners do.

3. You must understand the technology that can produce this visual language for you before any verbal or abstract ideas can be crystallized into visible form for sharing with your audience.

There's nothing esoteric about these three. The first two are common sense and need no further exploration. The third bears a little expansion.

Technology and its limitations

Nowadays, wherever we look, we see evidence of the importance of charts and graphs in communication. Practically every advertisement for computer hardware shows a little screen with graphics on it as proof that computers can do it better. We also see charts and graphs used ever more cunningly in the pages of consumer magazines when, not too long ago, they were only to be found in specialized publications dealing with economics, the sciences, and business. Charts have catapulted from the stock market pages into every other section of today's newspapers to illustrate (and prove) trends of all kinds. They appear on television as credible proofs of someone's (anyone's) claims, and no "presentation" is deemed complete without some attempt, however primitive, at visual leavening. In sum, the day of visual statistics is upon us, and we ought to make the most of it.

You may have to produce diagrams using nothing but common graph paper, a pencil stub, and a dented ruler to draw straight lines by, or you may have access to the latest computer technology. Clearly, the physical machinery at your disposal will have some influence on the way you think, what you can expect, and how the final product is likely to look. But you can get hopelessly lost in the mechanics of the diagram-making process. It is just like amateur photography: You can invest thousands of dollars on equipment and still produce nothing but snapshots. Your wonderful tools can save you from technical foolishness, but a good photograph dwells in the eye behind the lens. It is the photographer's interpretation of what is seen that makes the result greater than a mere record of what the lens saw when it was pointed at a particular scene. The same holds true of diagrams: The diagram maker's understanding of the facts and visual interpretation of their import makes the diagram valid and thus worthy of publishing. The technology utilized in their manufacture is a secondary consideration; it is just the means to an end.

The importance of a diagram lies in its content, not its form—although the form must express the content sympathetically. It lies least of all in the technology used to create it. So don't blame your tools if your diagrams lack life; don't say you didn't have the right kind of pencil, or enough money, or enough time. Nobody will care. All anyone will care about is the information. By the same token, be wary of overly elaborate, beautifully drafted, multihued efflorescence—it may be just as empty at heart as the most primitive pencil scrawl.

Michelangelo designed the dome of St. Peter's in Rome using the sixteenth-century equivalents of pencils, a board with T square, and a couple of boxwood triangles. He needed four bits of paper measuring about 20 inches × 34 inches each (large for the time) and a model. He managed the masterpiece without access to computer-assisted visualization, electrostatic reproduction machines, software programs, or anything else. All he needed was an idea. Figuring out good charts is no more difficult than designing a cathedral in terms of the originating graphics. That's why it is so much more important to be concerned about the rightness of the image than about the techniques used to make it. The old-fashioned way of making diagrams is just as valid as the newfangled way; in fact, pushing a pencil by hand allows more freedom for experimentation and imaginative combinations that are specifically tailored to the message at hand. Of course, some "wonder machines" yield similarly untrammeled results, but they are likely to remain outrageously expensive. Other, less expensive computers may be capable of making images, but they offer far less freedom and flexibility. They can, indeed, produce charts and graphs of colorful impact faster and cheaper than a person can. Graphics software is now available for everything from microcomputers to mainframes to allow you to produce automatically slides, overhead cells, or hard copy printouts. All you need to do is to select the chart form you

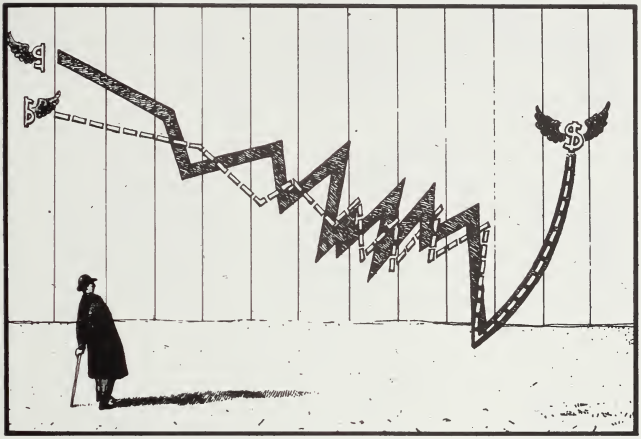
want from a sample book, punch in the data, and presto—out comes a marvelously colorful, accurate image with all the right numbers, labels, and shapes (if you punched in the right figures, that is). There's no doubt that you can produce some super graphics, but they'll have standard shapes and forms.

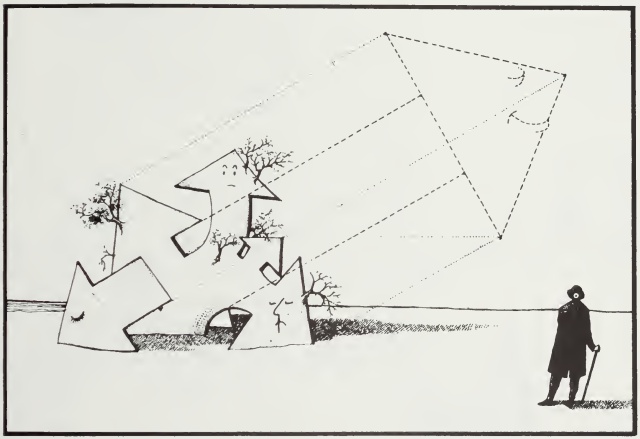
Imagination and its limitless breadth

Standardization, which is a logical result technology faces in order to be cost-effective, lies at the heart of the problem. The more expressive a language is to be, the greater the flexibility of its elements must be. The individual building blocks of which it is assembled must be inflexible: Each needs a precise definition, just as words must be used accurately to deliver the right meaning. However, the juxtaposition or arrangement of the blocks must allow for total flexibility. Additionally, there is one more area where flexibility is crucial: the background against which data are presented. In that relationship between the data and the context in which they are seen lies the greatest capacity for instant communication. That's where imagination can be brought into play and where the challenge of the medium lies.

Few computer-assisted programs allow you to be as inventive and as original as you need to be in order to do justice to your subject. It is obviously more useful to have accurate, straightforward statements of facts in chart form than not to have them, especially if the cost can be kept low. But no machine ever invented (or ever likely to be invented) will come up with insights such as these.

Three drawings by Martin Aveliez. Copyright © 1982 by The New York Times. Reprinted by permission





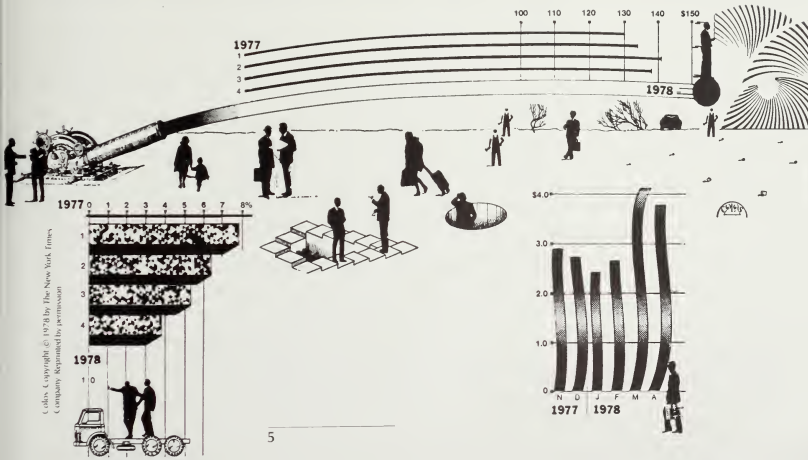
These three illustrations, from the *New York Times*, are by Martim Avillez. Their subjects are the most ordinary of the ordinary: a curve chart, a handful of arrows, and a map of the United States. But the artist's imagination has endowed them with a life of their own; the hackneyed clichés have been infused with personality, character, life, joy. Of course, it takes a special kind of mind to take the ordinary and transform it into

something extraordinary. Although the likelihood of your having to think this way is probably quite remote, that doesn't mean that these examples are not valid or important to you. On the contrary, they are shown here to prove that the capacity for imaginative interpretation is not limited by the shapes and traditions that have become standardized. Creative imagination can rise above and beyond the expected norms to reach fresh heights of insight and communication.

Colos. Reprinted from the December 1977 issue of *Fortune* by special permission. © 1977 by TIME Inc.

Here are three drawings by Colos—one is from *Fortune*, one from *Business Week*, the third from the *New York Times*. They are more down to earth than the Avillez drawings, because their purpose is different. Whereas the Avillez illustrations have symbols as their subject, the Colos drawings carry statistical information. Colos started with numbers, just as anyone else would have; he also understood the thrust of the story before he started. The result of the artist's insight is an accurate presentation of the data against a figurative, interpretive background that adds a human dimension to numbers. These become more understandable, more palatable, and much more enjoyable to look at and study. Not only is that good for the story of which they are a

Cobb. Reprinted from the February 20, 1978 issue of Business Week by special permission. © 1978 by McGraw-Hill Inc.



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part but it is invaluable public relations for the vehicle carrying that story. Such value is not restricted to the print media; it would be equally valid for the screen.

This book by Walter Herdeg, editor and art director of the Swiss magazine *Graphis*, is a collection of the best diagrams produced in the recent past from around the world. It is a compendium of creative thinking, visual interpretation, verbal/visual interpenetration. It shows the most creative fusions of the technical with the symbolic, the commonplace with the imaginative. It has had a profound effect on diagram making because it shows what can be done, given the need, the talent, and the means. In so doing it has raised the level of expectation at large.

Those are the heights. Let's return to the valleys.

Types of charts and diagrams

Each format for conventional chartmaking has evolved in response to a particular need. At their simplest, the following forms can be thought of as the fundamental classifications.

Pie charts show the proportion of parts to the whole

Bar charts show proportions related to each other, irrespective of the total

Column charts show comparisons of amounts

Step charts show comparisons of amounts over time

Curve charts or graphs show fluctuations over time

Surface charts show proportional trends over time

Dot charts show patterns from which conclusions can be drawn

Tables show facts in organized fashion without graphic plotting

Maps show relationships of elements in space

Flowcharts show relationships of processes

Organization charts show human relationships

Schematics show relationships of theoretical concepts

Time lines show simple time sequences

Time-and-activity charts show process in combination with time

Verbal step-by-step diagrams show stages of thoughts

In order to communicate the contents clearly and quickly, it is wise to use the format most appropriate to the purpose. That is why the chartmaker must be more than an "artist" or technician; he or she must also be an "editor." An editor's function is to interpret, process facts, clarify opinion. It is therefore essential that the chartmaker understand both the purpose of the basic format (e.g., the pie showing the percentages of a total) as well as the purpose of the data being reported so that the format can emphasize it (e.g., making one of the pie's segments stand out more than the others).

Are you comparing totals to each other?

Are you showing the relative importance of elements as components of a whole?

Are you showing the frequency of distribution over time or in a location?

Are you showing change over a period of time?

Are you showing the relative values of a variety of elements?

Perhaps we are intellectualizing the process a little too much; after all, we are so used to the basic chart forms that we gravitate automatically to their common formats. Are such knee-jerk reactions conducive to the best solutions? Are we not in danger of substituting habit for thought—habit that prevents us from thinking the problem through to a more vivid solution? To be sure, in most cases the straightforward solution may be the best. However, understanding the reasons that make the obvious obvious can increase our capacity for departing from the obvious whenever the opportunity arises. That's when the fun begins.

Why do we use charts?

To show and tell facts effectively

To save the reader's time since diagrams increase velocity of communication

To direct the audience's attention to aspects we deem important

To give the audience a context within which to perceive the important facts

To display statistical relationships more clearly than words or numbers permit

To plot relationships that could not otherwise be understood

To illustrate nonvisual concepts visually

To improve the effectiveness of communicating visual factors

All are worthy reasons for investing effort, time, and treasure. There are other reasons we need to ponder. They are perhaps less worthy in terms of communication value, but they have validity in practical terms for other purposes.

To embellish a product or presentation and thus gain attention

To prove how much research we have done and how much we know

To pack in statistics ancillary to the main thrust of the report

To keep up with the competition

To break up the grayness of the text on the page

To gain credibility, status, the appearance of being scientific

It would be folly to claim that such uses are unworthy and therefore ought not to be fulfilled. The complexity of purposes for which we prepare our products (whether they are presented in print or verbally) rules out any such generalization. Knowing the true function of the diagram in its context, however, can guide you to the right decision; if it is important, then the investment is worth making. If a diagram is essential documentation, only the best can be good enough. If it is decorative, the good enough may well be good enough.

What is needed to make good diagrams?

1. *The correct and final numbers.* You cannot start plotting without them, because you cannot determine the scales that define the field. Charts cannot be plotted theoretically, for their effectiveness in explaining the underlying significance of the data depends on illustrating relationships precisely. That is a function of physical proportion. Therefore, you must gather the facts first.

2. *Ample time.* It takes time to develop the ideal format because it is essentially a matter of trial and error. Clearly, an experienced diagram maker can telescope the time by virtue of that experience—knowing what to look for and how to handle it. Having access to computer drafting is also helpful (after all, a computer is just human experience that has been programmed and mechanized). That's why you have to have time to do it wrong the first time and remake it without hysteria.

3. *Lots of money.* The services of an expert are justifiably expensive. Even the computer graphics expert is expensive by the hour. The less you can afford, the more amateurish your supplier and the final result are likely to be. Although it is cheapest to do it yourself, you ought to consider whether your time would not be better invested doing something else. Consider the best service you can afford—and opt for the even more expensive one. If it's worth doing, it's worth doing well, and the expert is most likely to deliver what will pay off where it matters: your audience's excitement.

4. *The right talent.* The "artist" you hire will need to be much more than a pencil pusher. He or she will have to understand the purpose of the diagram in its informational sense, whether it is propaganda or a visual expression of numbers arranged in symbolic shapes, or, worst of all, decorative patterns of pretty shapes and colors. Your artist must blend the necessary graphic skills with an intellectual understanding

of the reason for publishing so that he or she can make the most of every element. That is a matter of *judgment*—not artistic judgment but rather journalistic judgment, something that is rarely found in recent art school graduates. If you want striking diagrams that are more than just visual embellishment, you need vendors who have confidence in their own judgment. Such people tend to be experienced and, by definition, a bit older and worth more; but the larger investment will result in better diagrams and fewer hassles. Good charts are sophisticated tools of communication that cannot be done well by just anyone.

5. *Clear ideas.* The writer/editor/originator of the report/article/treatise/lecture must articulate what he or she wishes to have communicated by means of the diagram. It is a sophomoric misuse of the medium's potential just to show numbers in diagrammatic fashion. There must be a significance to their presentation that can be emphasized. A good diagram shows more than the data; it makes clear—at first glance—what the significance of the data is to the viewer. That meaning is revealed by the basic arrangement of the data, by their geometric proportions, and by the related text. The artist must be guided by the editor in that interpretive function because it is integral to the creation of diagrams. The making of such images is an organic process of growth that is based on a clear grasp of the message to be communicated.

6. *Ambition.* The process of diagram making is so frustrating, slow, changeable, and fraught with stumbling blocks that it is much easier to give up halfway through, when the obstacles appear insurmountable, than to continue the struggle. The will to see it through to the bitter end is essential.

Characteristics of a good diagram

1. *Elegance.* This term is used here to describe the simplest and most fitting solution to a problem. It implies an economy of means to achieve the desired result. You don't have to dress up anything to make it "look better." It is far wiser to spend the effort searching for the essence of the underlying idea so that it can be presented as precisely as possible. Edit the material down to its essence, then find the simplest technique to show it—and stop.

2. *Clarity.* Interpreting the meaning of a diagram should not be left up to the viewer. Too few instances call for so neutral a presentation of data that no conclusion can be drawn. Instead, use the clearest words to reveal the meaning right away. Avoid cutting sentences into labels or speaking in telegraphese; both require too much study and concentration on the reader's part. Instead, see the diagram as a paragraph of information that needs a proper headline to introduce its purpose and define its direction. Only with such an explanation can you ensure the reader's curiosity to delve deeper into the facts presented. Labels cannot arouse such curiosity unless the viewer is already predisposed to be interested in the subject at hand—something you cannot always depend on. The old journalistic adage that you must "tell 'em what you're gonna tell 'em, then tell 'em, and then tell 'em what you told 'em" is as true for diagrams as it is for written copy. Explain the significance of the data to the reader when you write the caption. That way you have created a satisfying microcosm of communication—the title states a provocative claim, the diagram a credible proof, the caption a cogent

explanation. The viewer is bound to follow the steps and come out informed and caring. But if you omit any of the steps, the viewer will substitute his or her own viewpoint and so derive conclusions that may make little sense in terms of your story.

3. *Ease.* If you want the reader/viewer to respond, make it easy to do so. Eliminate as much labor as possible. Label each element within itself so keys can be avoided. Use big, easy-to-read type. Never think of labeling as a nuisance that spoils the handsomeness of the graphics. Words and graphics are integral elements in the storytelling process and must be in comfortable balance.

4. *Pattern.* The reader/viewer expects certain things to be shown in certain ways any time you have more than one diagram. Utilize this quality of expectation that repetition can create and build on it. Avoid arbitrary changes just to create artificial variety—that just leads to confusion. Instead, repeat what logically should repeat, creating a rhythmic base pattern that becomes a foil against which any departure from the pattern will leap out at the viewer. (This technique should be used only when radical departure makes good sense, not for its own sake or for mere variation.) Creating patterns is a far more satisfactory method of communication than making each diagram as different as you can in order to create artificial visual excitement. You don't want the diagrams' own personalities to interpose themselves between the viewer and the message, lest you lose both viewers and message.

5. *Simplicity.* Whatever does not need to be in the diagram to make a point should not be there. Use only the amount of background grid that makes the data plotted on it intelligible. Concentrate the viewer's attention on the main points by making them big and bold to contrast colorfully against small, light, and pale. Add imaginative backgrounds to illustrate the context or meaning of the statistics. Use every element, including the lines themselves, as active participants in the diagram's meaning. (For instance, whittle the ends of flow lines into arrow shapes so that the direction of relationships in an organization chart is integral with the way its connecting lines are drawn.) The viewer's time is valuable, so anything you can do to make a diagram easier to understand and absorb is desirable. It is usually true that less is more.

6. *Validity.* It is sometimes far more effective to present statistics in simple tabulated form than to turn them into symbolic graphics. Often, numbers ought to be presented as numbers, because they are most believable that way. Only when their significance goes beyond themselves should you consider turning them into something else. Knowing when not to start at all is as important as knowing when to stop in order to keep it simple.

The next seven chapters are devoted to showing the basic chart forms in detail. There is a lot of material here to illustrate the richness of communication value as well as graphic variety that each is capable of yielding.

Chapter 9 is devoted to showing how to make the most of groups of diagrams by tying them together visually in frames. Many publications derive much of their visual personalities from the use of such framing systems, for the frames become the

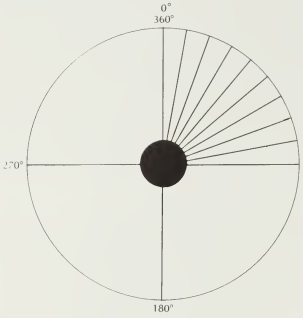
trademark of the vehicle, while the actual diagrams inserted in them can be as varied as they need to be.

Chapter 12 offers tips on how to make charts. But Chapters 10 and 11, I find, are the most exciting. Chapter 10 is an essay on the interpretation of symbolism, a topic that sounds esoteric but that is, in fact, very practical. How an audience reacts is crucial to diagram making, and often readers respond far differently from the way we diagram makers expect or hope they will. But just as there is an infinite variety of audience reactions, so too do we as diagram makers have the means to direct or at least influence those reactions. The number of ways in which we can shape readers' interpretations is demonstrated by the staggering variety of meanings a symbol as simple and universal as the arrow can convey. The multiplicity of meanings arrows communicate should be as instructive as it is amusing. It is perhaps the best argument for keeping the substance and form of our diagrams as simple and unequivocally clear as we can possibly make them.

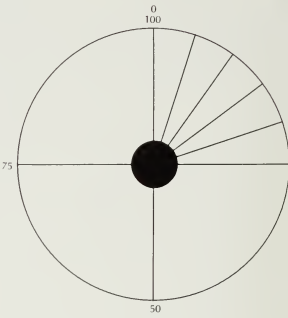
Chapter 11 delves into combining chart formats into hybrids and exaggerating various graphic aspects of diagrams to encourage unexpected interpretations. This may be seen as misusing graphics to bamboozle the viewer or, put more bluntly, as a means of cheating with statistics. While outright deception is undoubtedly a misuse of graphic techniques, the ability to manipulate appearances is integral to the use of graphic tools. Just as meaning can be shaped through turns of phrase and choice of words, so too does the language of graphics offer the freedom to use visual twists and turns. This flexibility is, in fact, the ultimate proof that diagrams speak a language as clearly and convincingly as words do.

2: PIE CHARTS

■ The circle is a shape that is universally understood to represent a totality, a whole, a complete unit. In mathematical terms, that concept is expressed as 1/1 or 100 out of 100. (In Latin, "by the hundred" is *per centum*—written in scribes' shorthand as %.) Therefore, we can say that the circle equals 100.

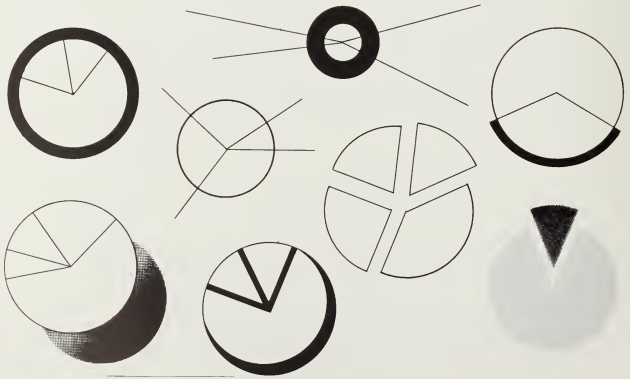


In geometry, the circle is divided into 360°.



In a pie chart, the circle is divided into 100 segments.

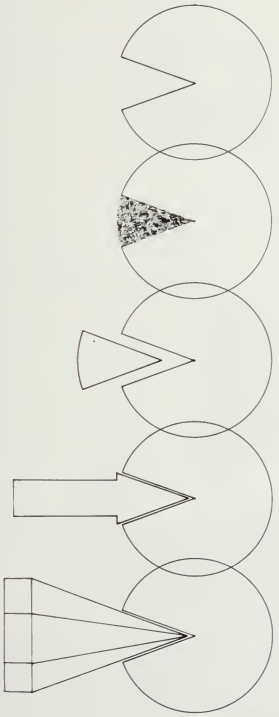
The circle is broken into segments (slices or wedges) proportional to the sizes of the elements to be plotted. In practical terms, it is best not to show more than six such wedges, because more than that tends to confuse—and confusion is to be avoided. After all, the purpose of making diagrams is to clarify difficult ideas. If it makes them more difficult to absorb, the diagram needs to be changed, or the idea simplified; either alternative would be preferable to giving the reader a set of neatly tabulated statistics and letting it go at that. To show that a pie chart can, in fact, be a visually interesting element on the page (in spite of the fact that it has become something of a cliché), here is a sampling of the wide variety this format offers.



Using the pie chart format

The pie chart* is an interesting way to show statistics when the proportion of the segments to the whole is important. Its greatest usefulness lies in its capacity to dramatize that factor, particularly when inventive or decorative draftsmanship, color, or other embellishments are employed. It is not as clear in depicting accurate comparisons of raw data as, for instance, a whole-bar chart is (see page 29). But then a bar chart isn't nearly as visually captivating as a pie chart, especially if the pie is floating in the air, seen from below, or if it has been embroidered with some of the finery you will see in the illustrations in this chapter.

Focusing attention on one important element among many is often the purpose of using a pie chart in the first place. It can be done by several methods.



Leaving the segment out altogether (its absence makes it conspicuous).

Adding strong color contrast—dark against light, if it is in black and white; or bright color against a muted one, if color is available.

Allowing an important segment to poke out beyond the confines of the encompassing circle.

Making the segment become an element of something outside the pie itself, such as an arrowhead.

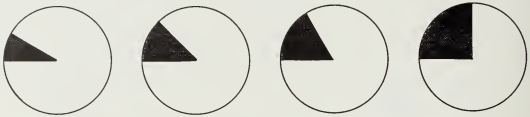
Breaking the segment into subcomponents outside the pie.

*Also known as sector graph, sectogram, or circle chart.

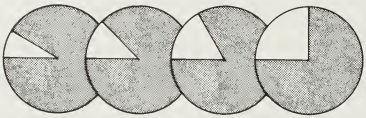
Comparing segments in pie charts

Although the pie chart format is better suited to showing the proportions a single unit is divided into, comparisons between segments of several units are also possible. Here are a few thoughts to bear in mind.

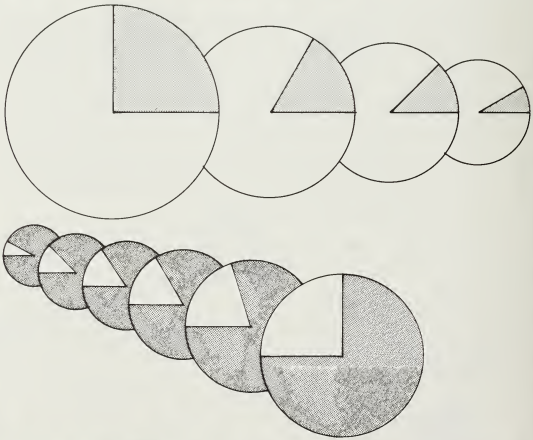
Aligning pies like ducks in a row is dull; besides, it takes up a lot of space.



Overlapping the pies looks much more interesting and can work if each pie is simple and there is no overlapping of important statistical matter. Note how keeping one edge of the slivers aligned horizontally makes it easy to discern the differences between them.



Overlapping the pies is particularly effective when the pies vary in size, though "growth" (i.e., a steady enlargement) is even more effective when the row of pies is shown at an angle.



Comparing statistics in pie-wedge form without showing the rest of the pie can be useful.

Here is a group of wedges; if they are ranked by size, the statistics read even more clearly.

It is wise to show the entire curved edge of each segment, and wisest of all is to make each slice's horizontal edge horizontal. That way visual comparisons can be made most readily by the viewer.

Pie pictures

The circle need not be an abstract geometric shape. It can be anything you want it to be, as long as it has some symbolic meaning appropriate to the substance of the statistics being represented or the story being told. Among the many variations on the circle, coins are the most obvious; anything else that is circular is just as liable to manipulation: apples, tires, phonograph records, doorknobs, hats, pills, light bulbs, pots, armadillos (curled up), puffer fish, Ping-Pong balls—in fact, balls of all sorts.

If you show the object as a solid sphere, then indicating the slices can be done two ways.

1. The original sphere may have the segments painted on it in some way, and the whole object is then photographed and reproduced.

2. The sphere's image, printed flat on the paper, can be dismembered into segments, or lines indicating the segments can be superimposed on it to indicate proportions.

You can cut up the coin into segments or superimpose dividing lines (stripped in as line art) to show divisions.

This basically flat picture is perfectly expected and obvious. When it is tipped sideways, a much more interesting result is achieved.

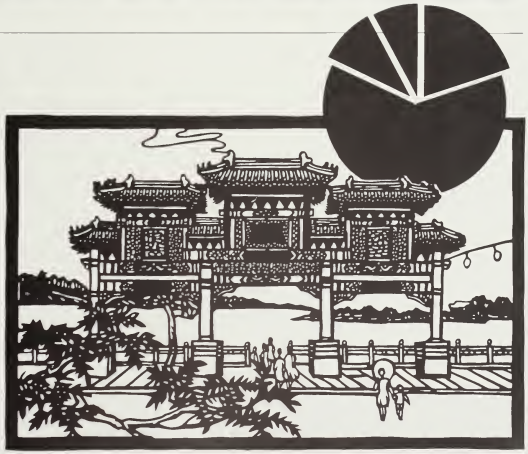
Here is a coin seen at an angle. It is more difficult to indicate the segments, since naturalistic rendering is necessary to make the illusion work.

The most interesting effects can be had from pie charts that are grafted onto other background art in some way—the statistics become amusing and challenging communication.

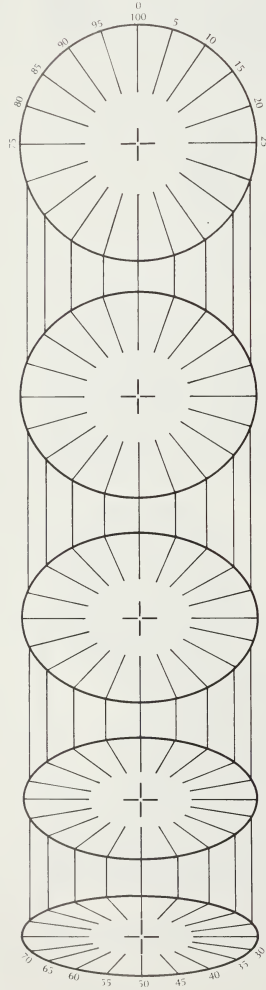
Contrasting a statistical statement with a cartoon commentary allows subtle editorializing.

Inserting a drawn pie chart form into a photograph allows the statistics to be seen in a storytelling context.

Any form of artwork or illustration can be used as a foil to the statistics. This is an example of Chinese folk art, with the moon added.



Tipping the pie



A flat circle is just that: a flat circle. But if you look at a circle slightly to one side, then its dull stolidity is replaced by a more dynamic sense of motion and floating —especially if the axes of the ellipse (which is what a circle seen from the side happens to be) are placed off the vertical/horizontal.

How do you make such diagrams? It looks much more difficult than it really is; in fact, it's as easy as pie, if you forgive the pun.

It is true that constructing ellipses from scratch is a tricky process demanding drafting expertise or sophisticated software. There is an alternative: Simply buy templates at the art supply store. They come in a wide variety of projections (angles) and sizes —more than you are ever likely to need. You can also buy an ellipse-drafting machine if you require highly specialized variations.

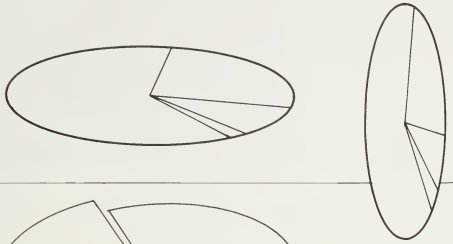
Once you have drawn the ellipse of your choice, you need to break it up into the necessary segments. This is perhaps the right place to face up to a problem with such figures: It is difficult to be accurate *at an angle*. In practical terms, it is easy to be precise within a couple of percentage points, but if absolute accuracy is required, perhaps you should not use this stilted format to begin with. Its capacity to add visual interest and drama is the reason why it cannot be accurate: The narrow ends of the ellipse squeeze the grid together so that some of the plotting is necessarily guesswork.

In order to divide an ellipse into its segments, you start by placing your flat protractor directly above the ellipse —both must have the identical horizontal axis diameter. You "drop" a perpendicular line from the protractor's markings to the ellipse; where these vertical lines intersect the circumference of the ellipse, place tick marks (these points then correspond to those on the protractor). In the diagram here, 5 percent increments are shown.

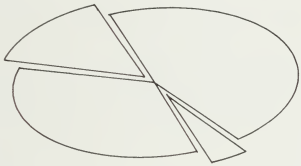
To divide ellipses into segments corresponding to those of a circle of the same size, draw vertical lines from the circumference of the circle to the circumference of the ellipse.

Here are a few examples illustrating the capacity of ellipses to improve the visual liveliness of statistics shown in pie chart form.

Identical shapes: the circle "lying down" and "standing up."

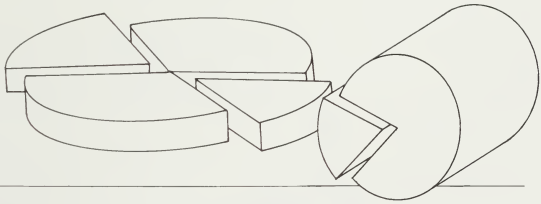


It is possible to pull segments out of an ellipse the same way you can dismember a circle.



The illusion of solidity and thickness is created by drawing the identical figure twice (one above the other) and joining the vertical edges with lines.

Pulling slices out of a three-dimensionalized pie is more satisfying than doing it on a flat plane. If the figure thickens into a cylindrical shape, it looks more like a wheel of cheese than a pie.



Tilting ellipses at angles other than the expected vertical or horizontal creates an illusion of floating images. Pies turn into flying saucers, especially when viewed from below.

Three problems with pie charts

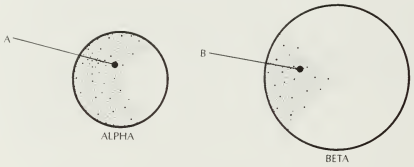
1. Accuracy

It is, regrettably, easy to make mistakes when plotting along the circumference of a circle; linear measurements such as those used for bar charts are easier to accomplish with precision. Even the best 100-segment protractor or preprinted circular graph paper still requires more care and takes more work to do it right. Naturally, computer-based plottlng depends on the quality of the software used, and here's one area where the excellence of the new technology can be helpful. Data and its geometrical proportioning are ideally suited to computerized analysis and plotting. Unfortunately, most of us work without the benefit of such marvels and so have to work harder at achieving accuracy.

2. Comparison

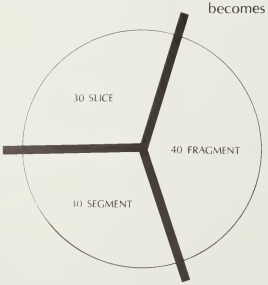
It is quite difficult for the viewer to interpret the comparative sizes of pie-shaped slivers if they are small. Furthermore, it becomes nigh on impossible to do so if the comparison is made between slivers of different-sized pies.

In this diagram, where we have to compare slice *A* with slice *B*, how can we be sure that the one is greater than the other in their totality? Certainly *A* is the dominant element in Alpha, and *B* is just a minor element in Beta. But how do they compare to each other?



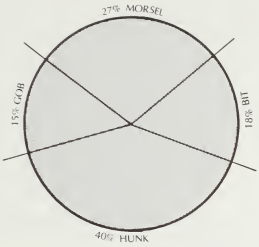
3. Labeling

It is difficult to decide how best to label: Inside the figure is most sensible (if there is enough room), but should the labeling go around the circle or horizontally? If there isn't enough room, should it radiate outward from the center, or should it be called out with arrows? Combining the appropriate labeling with the ideal pie chart form becomes a very important, albeit trying, issue. Here are the basic options.

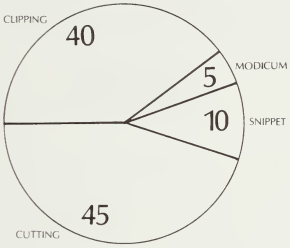


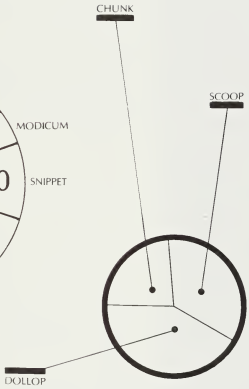
Statistics and names inside the circle.

Information surrounding the circumference.

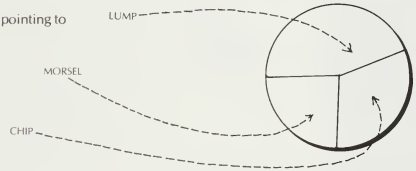


Numerals inside, descriptions outside the circle.

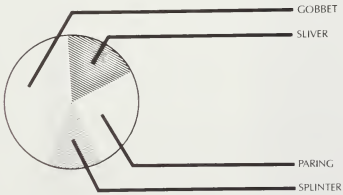




Names (with or without statistics) as callouts, with arrows pointing to the areas to which they refer.



A tabular effect created by aligning labels. The arrows leading to their respective areas are formalized, starting out horizontal, then turning at an angle.

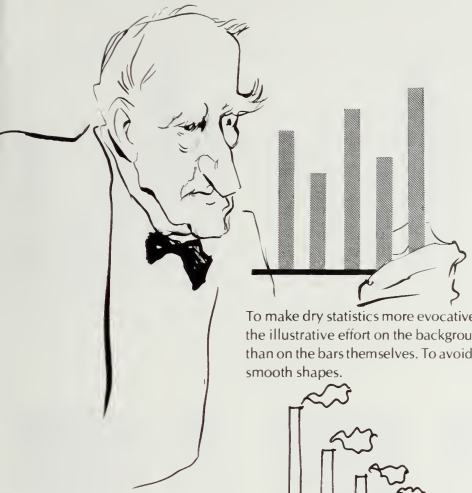


■ They can be simple or extremely complicated. They can be vertical (in which case they are strictly called *column* charts) or horizontal (in which case they are true *bar* charts). They can be single, multiple, pictorial, geometric, flat and two-dimensional, or they can appear to be three-dimensional. They can be dry and statistical, or they can be full of imagery expressive of the subject matter. You must choose the degree of graphic embellishment suited to the purpose and context of each chart.

Bar charts, stacked horizontally, are ideal for comparing amounts because they can be arranged any way to suit the editorial purpose. They can be arranged alphabetically, sequentially, in descending order by size, in random sequence, and so forth.

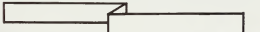
Furthermore, since the bars lie sideways, there is usually ample space for labeling that runs in the same direction as the bar itself inside or outside each bar. The result of this synthesis is speedy, efficient communication.

Column charts, whose bars are arranged vertically next to each other, are more specialized; for the reader is predisposed to attributing to them a time sequence (running from left to right) even when none is intended. That gives them an advantage: They are excellent for showing comparisons of specific amounts, especially if *trends* are a useful by-product of that information. An argument against their use is the difficulty of labeling bars: Should the wording run sideways (up the bar), which is hard to read and unpopular (and therefore detrimental to fast communication), or should the wording be attached to the bars some other way? This question often creates problems, but must be resolved.



To make dry statistics more evocative of their subject, it is often wiser to concentrate the illustrative effort on the background against which the bars are to be seen rather than on the bars themselves. To avoid confusion, it is better to present the bars as clean, smooth shapes.

Transforming the bars into pictorially descriptive symbols such as chimneys or stacks of coins, or rows of people is, clearly, also acceptable. It is important to bear in mind that neither bars nor columns are hard, crystalline objects. Think of them as being made of soft, pliable, breakable material. The only factor that matters is their length, for that describes the statistical value. The material of which they are made can be manipulated as the situation demands. For instance, if the bars are too long to fit into a given space, why not fold them back?



You can break them  , roll them back 

and even squash them 

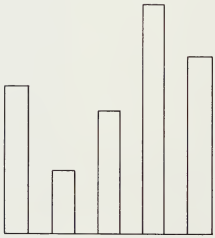
Since the options are so varied and since they are all interconnected, this chapter is organized into what may appear to be arbitrary groupings. The problem is that any degree of rendering—be it simple or complex, pictorial or in perspective—can be applied to any bar chart format. To show the full range of each kind would require a whole book in itself. So you must examine the options shown and remember that you can carry the presentation technique of your choice as far as you wish, even if that specific technique isn't used to illustrate the specific chart groups used here. Whatever combination you choose, always be certain that the technique is appropriate to your communication goal.

The subject matter and the form of the statistics can be married into a stronger statement, because the viewer's interest is more intimately piqued. As a general rule, it is probably safer, for the purpose of safeguarding the integrity of the statistics, to work on the context in which the bars or columns appear. It's not just *what* you do but *how* you do it that matters—based on a good reason for *why* you're doing it.

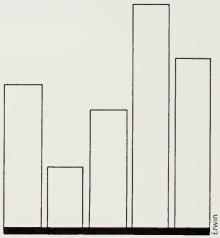
The quality, thickness, precision, and accuracy of drawn lines, their relationship to each other and the shapes they enclose, the spaces between those shapes, and the background against which they are seen—all are rich areas for experimentation.

When you broaden the possibilities by adding color—whether that be actual change in hue or merely change in tone values of one color (normally black)—you have so much to choose from that it may not be necessary to venture into the more difficult areas of draftsmanship that are shown later in this chapter.

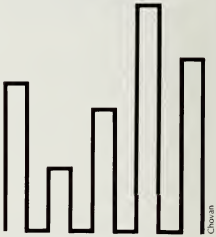
How the various presentation techniques are used to communicate meaning and how they are interpreted by the viewers depend on the subject and the context in which it is perceived. The examples here are merely a group of options chosen at random from the unlimited range of possibilities at the designer's disposal. Variations of the basic column chart, they are, obviously, drafting techniques that can be applied to bar charts, whose bars run horizontally, or to any other drafted shape. What we are examining here are the relationships of variables used in drafting techniques.



Columns drawn the same width as the space between them—all in fine, light line.

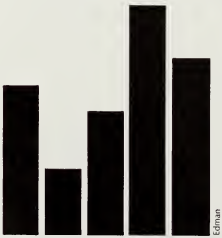


Broad columns sitting on a heavy baseline. Contrasts in line value give the diagram color and make it interesting.

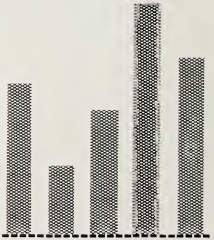


Boldly drawn lines enclose shapes springing from a baseline that is only partially indicated.

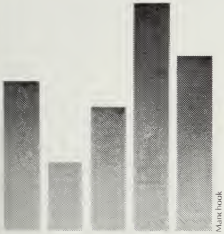
Deliberately fuzzy outlines.



Columns shown as solid color (here, black) or with a screened tint.

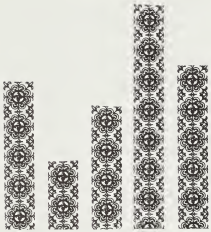


Texture used to delineate the columns, seated on a dashed baseline.



Varied color tinting, using adhesive material.

Placing emphasis on one column by means of color contrast.

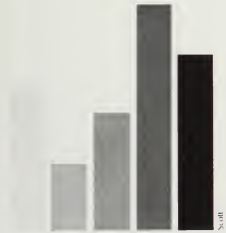


Making the columns of a material significant to the meaning of the chart.

Black background for white columns.

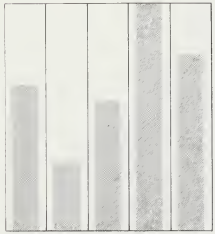
Shaded background for white columns.

Textured background for white columns.

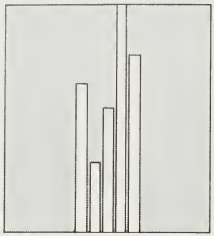


Multicolored columns on a white background.

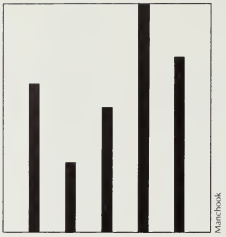
Multicolored columns on a shaded background.



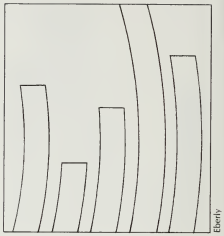
Gray columns, each in an individually articulated space.



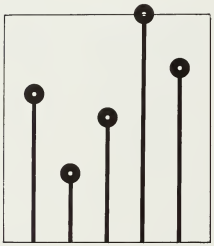
Narrow columns closely spaced on a gray background.



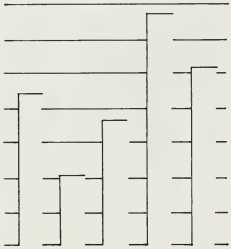
Narrow columns widely spaced on a white background.



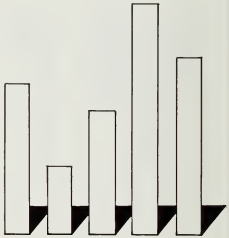
Curved columns.



Columns supporting balloons, which identify the data.



Columns whose definition is indicated by lines in the background.

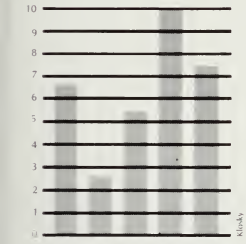


Columns whose presence is emphasized by the "shadows" they cast on the background.

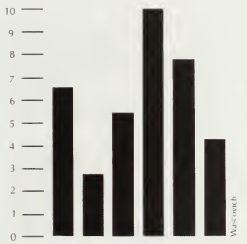
Field, background, grid, labeling

As with bars or columns themselves, the variety of choices available for rendering the background and ancillary material is daunting. You can go from no background at all to one that is a picture of the subject and thus give the statistics a context. You can have a grid that emphasizes the minutiae of mathematical facts, or you can have none at all. You can put the numbers outside, inside, sideways, or even substitute pictures for words. The following examples are self-explanatory.

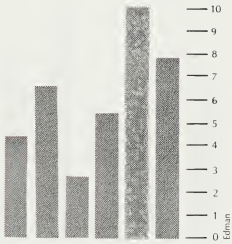
How do you decide which to choose? The answer, quite simply, is whichever seems to make the most sense in your particular set of circumstances. There are no rules, despite what you may have learned in high school math class. The only guiding principle should be the communication value of the graphic rendition of the statistics, or, to put it another way, how incisively the technique has been chosen to help carry the ideas in the diagram into the viewer's mind.



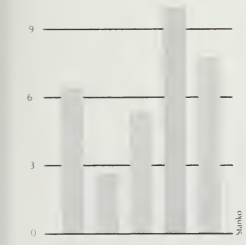
The horizontal grid dominates the image.



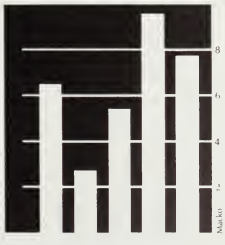
The horizontal grid reduced to "ticks" on the left-hand edge.



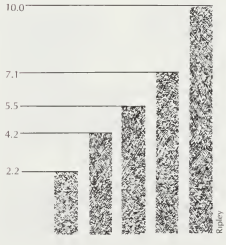
The tick marks of the grid placed on the right-hand edge imply "result."



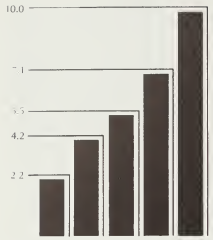
The columns overlap the grid, thereby reducing its importance.



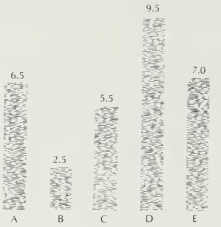
Field and grid combined into one background element.



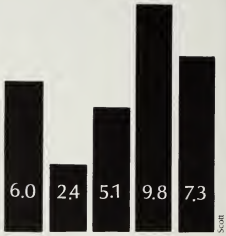
Grid lines emphasizing the data.



Grid lines used decoratively.

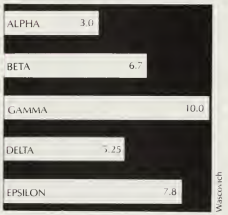


Numbering outside the columns.



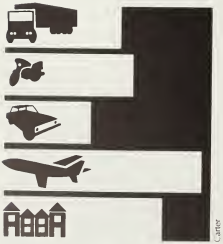
Numbering inside the columns.

Numbering inside the columns, with the type reading sideways ("on its ear").

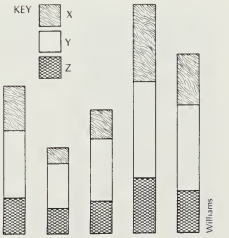


Bars laid sideways provide better spaces for lettering than columns do.

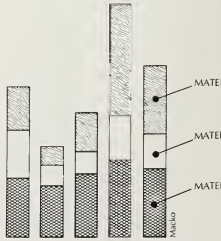
Pictorial symbols used in lieu of words.



Pictograms used in place of verbal labels in bars.



Use of a key to explain the meaning of the various shadings.

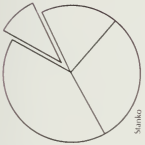


Use of callouts to label the various areas.

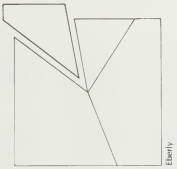
Segmenting the whole

If you have a total (usually 100 percent) and need to show the segments into which it is divided, a pie is usually the most understandable form—for the circle is perceived to be a complete or "whole" figure. (For more on pies see Chapter 2.)

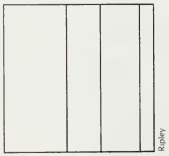
Unfortunately, the triangular slivers of a pie shape often do not reflect area as clearly as they reflect the relationship and proportion of the part to the whole. Where area comparisons need to be made, a square or rectangle broken up into its component segments may be clearer at first glance.



Pie chart. Proportions of the whole indicated by slices cut at appropriate angles.

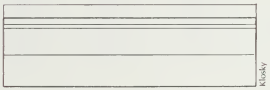


Square pie. Radiating slices may be identical in angles to those shown in the pie chart at left, but they mislead in terms of area because of the square shape.

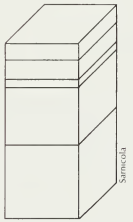


A segmented square is much clearer than a square pie; it is also more accurate and more accessible to the viewer.

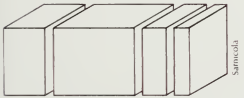
Vertical rectangle showing its internal subdivisions.



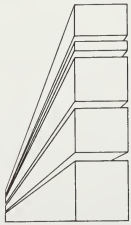
Horizontal presentation of the same statistics as those shown at left.



A more elaborate presentation in three dimensions.



A bar in three dimensions, segmented and separated.



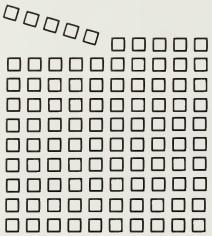
Segments of a bar separated and stacked in dramatic perspective.

A column's segments pushed sideways.

Segments skewed and cantilevered.

Segments shown balanced at angles.

Symbols implying a total of 100, segmented by superimposed lines.

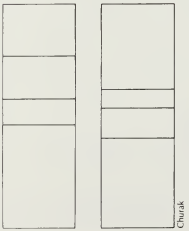


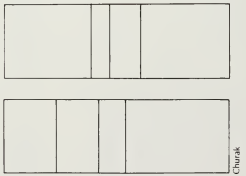
The whole represented by 100 units from which a countable segment is broken off.

1	2	3	4	5	6	7	8	9	10
11	12	13	14	15	16	17	18	19	20
21	22	23	24	25	26	27	28	29	30
31	32	33	34	35	36	37	38	39	40
41	42	43	44	45	46	47	48	49	50
51	52	53	54	55	56	57	58	59	60
61	62	63	64	65	66	67	68	69	70
71	72	73	74	75	76	77	78	79	80
81	82	83	84	85	86	87	88	89	90
91	92	93	94	95	96	97	98	99	100

The total (100) shown as numbers.

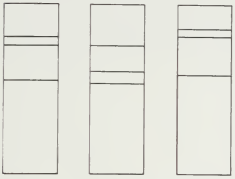
When you have two or more wholes to compare, the pie chart form loses its clarity, for the pie slices are hard to distinguish from one pie to the next. In such cases, bars, each representing 100 percent, are clearer. It does not matter whether the bars are lying on their side or standing up as columns, as, regardless of the position, the segments of which they are composed can be discerned more readily.



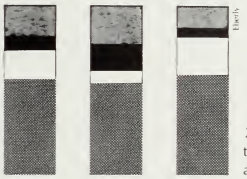


Comparing segments of two vertical or two horizontal bars is a visually effective technique.

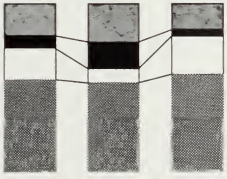
Comparing segments becomes increasingly difficult as the units multiply. To help overcome the difficulty, you can:



1. Place the dominant element at the bottom of the columns (or the left edge of the bars if they are lying sideways) so that it acts as a visual base against which other segments can be measured.



2. Use clearly differentiated colors or textures to help distinguish one set of segments another set.



3. Join the tops of the segments with lines to help the eye bridge the gap between neighboring columns, especially if trends or relationships are an aspect of the data that require emphasis.

Area comparison diagrams

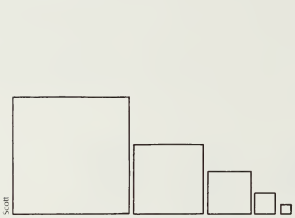
This variant on the bar chart is often confused with the segmented bar format; it is shown here to make the difference between them immediately obvious.

Instead of showing parts of a whole, where the whole is the encompassing shape (as in the bar chart), in the area comparison diagram the parts are exploded from the overall shape and their relative sizes become the basis for comparison. The totality is understood and implied; it also need not be based on 100 percent. The units can represent specific numbers that are proportional to the whole, irrespective of what the sum total may be.

The square is a geometric form that is as self-contained and complete as a circle. That is why areas (sizes) of squares can be compared and understood clearly. Thus,

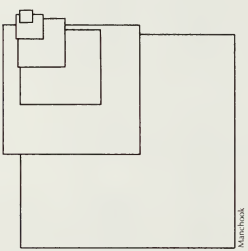
simple statistics can be illustrated, especially when the subject of the statistics lends itself to such visual interpretation. Geographic areas, production figures for flat materials such as cloth, collections of physical entities occupying space, and other dimensional objects or concepts are ideally suited to this treatment of comparison.

Needless to say, shapes other than squares can be used to equal effect. However, there is magic in the square: Its very obviousness makes it suitable as an abstract symbol.



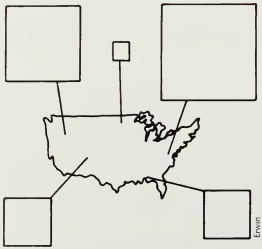
Squares neatly arrayed for ease of comparison.

Squares overlapped for comparison.



Overlapping squares stacked in order of size create an appearance of planes in sequence.

Squares staggered in free overlap pattern.

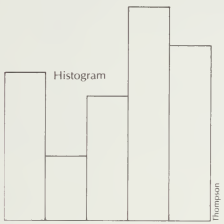


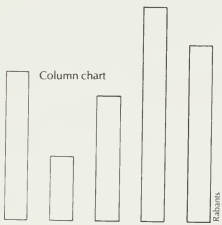
Squares symbolizing comparative sizes tied into a matrix diagram.

Squares cubed and viewed in dramatic perspective.

Step charts or histograms

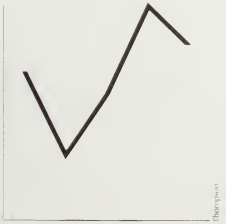
The difference between a histogram and a plain column chart is simple in graphic terms. In a histogram the columns are touching, whereas in a column chart the columns are separated.





Our habit of reading from left to right influences us to think that the horizontal axis represents a series of coordinated intervals flowing one after the other. When the columns touch, that left-to-right sequence is brought to the fore, and we tend to interpret connected columns as being related to each other over a period of time. They have lost their independence and have become part of a continuum. The histogram, or "step chart," is more complex than a column chart; for it not only plots comparison (as does the column chart) but it adds a dimension of relationship. The relationships are perceived in terms of *frequency* or *amount* on the vertical axis and in terms of *intervals* on the horizontal axis.

The histogram shows a sequence of abrupt periodic changes. If such changes signal a trend, it is possible to emphasize that fact by drawing a line from apex to apex.



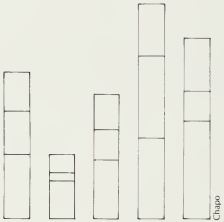
This simple figure bears an impressive name, *frequency polygon;* and impressive though that may sound, the principle remains as elementary as a set of points joined in space. If you omit the columns, you have—exactly!—a simple graph.

Divided bars and columns

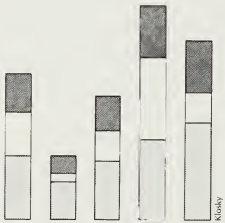
On page 29 we showed how bars and columns could be divided into segments—and here we are again, apparently repeating the same thing. Graphically, the technique is indeed identical. The meaning, however, is quite different. Whereas the bars on page 29 represent an abstract totality (100 percent), the bars here represent specific numbers indicated by their relative lengths. The lengths relate to scales (not shown here but essential to the understanding of the statistics).

Columns can be subdivided into components and, when they are so divided, the result is known as a *compound bar graph*. As in the case of the frequency polygon, the nomenclature is a trifle daunting, even if it is perfectly descriptive. Perhaps it helps to humanize it a little if you think of a compound bar graph as a totem pole.

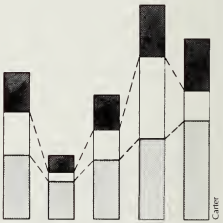
The same principles for making the information easily accessible in segmented bar charts apply to this form of diagram.



Place the largest element at the foot of each column.



Use varied tones to differentiate the segments from each other.



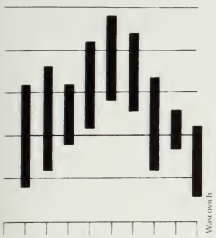
Join the segments with lines for smoother identification of trends.

Floating range bars

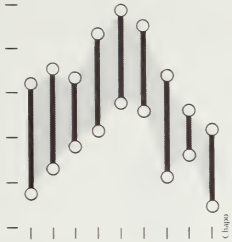
Often values that need to be illustrated in order to compare data do not start from a common point such as zero. A series of highs and lows or other fluctuations, such as you might find in stock exchange reports, requires charting in relation to each other. They need to be tied to a common scale, but the purpose of the diagram is not to show how far each individual element has traveled from the baseline, but rather how it compares to other data—the bar preceding it.

The scale can be oriented vertically or horizontally. With the vertical orientation, the bars bob up and down like corks; with the horizontal orientation, the bars swim back and forth like fish.

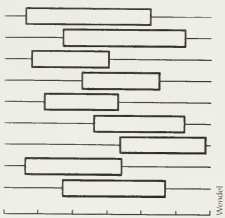
Charts of this type show two sets of interrelated facts: They compare lengths of the individual bars (yielding data on amount of increase and decrease of the total sum involved) and they compare the position of the bars in relation to each other on the scale (yielding data as to performance over time). Here are three typical examples.



Range bars floating on a simple grid.



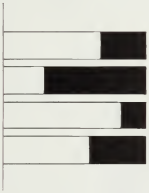
The extremities of each range bar are highlighted. The trend over time is emphasized by shading the enclosed area.



In this horizontal range bar presentation, each individual item is to be read separately. The vertical relationship seems less vital here.

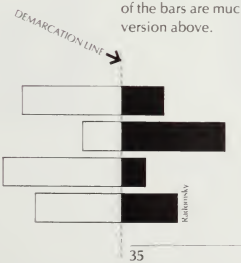
Sliding bars

When you have totals of comparable magnitude in which the proportions (such as percentages) differ, the most effective visual means of making the comparison is to use *sliding bars*. Here is a diagram showing four bars of equal length, each divided into two segments of various lengths. They form a clear square shape —and their overall sameness can be discerned clearly. You have to study the inner segments before you can compare their values in relation to each other.



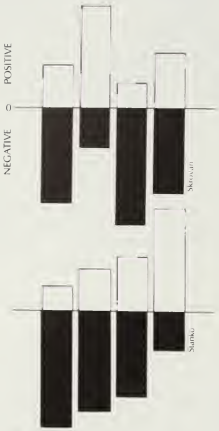
These bars are of equal length but their inner segments, compared to each other, are not. The major criterion for this arrangement is the equality of the lengths of the whole bars.

If the comparison were to be made not between the overall bars themselves but, rather, the inner segments, then using a demarcation line would yield a much clearer idea of relative proportions at a glance. The trade-off is that comparisons of the overall lengths of the bars are much harder to make in this version of the diagram than in the original version above.



Unequal segments within bars of equal length can be compared by aligning the segments along a demarcation line. The criterion for this arrangement is the need to compare proportions of segments to each other.

The generally understood implication of sliding bars run vertically is that everything above the datum or dividing line is positive and everything below it is negative.

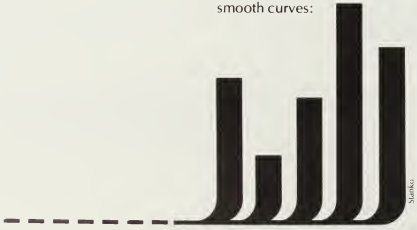


The "zero" line is the boundary between positive values (above) and negative values (below). The fact that the overall length of the bars is equal is unimportant.

The principle can also be developed a step farther by ranking the bars according to length. Such an arrangement communicates change and proportions clearly and succinctly.

Soft columns

If you consider the horizontal axis as representing the causative factor in the rate of change of various columns, then you can tie the movement into the diagram graphically. Columns can be made to appear to originate out of the horizontal in smooth curves:



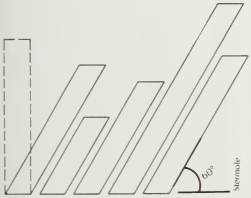
A variation of this principle is to consider the background or field of the chart as a plane (such as a window shade), behind which the causes for the variations in column lengths occur. The resulting image of columns sneaking out from behind the screen can make dull statistics more lively, especially if the implications of the background image can somehow shed light on the meaning of the report.

Diagonal bars

Bars run horizontally are essentially static as an image, however dramatically the length of the bars may vary. Columns standing up vertically can be more expressive, especially if they are touching and thus imply a trend from left to right. When you want to show a trend or "improvement" as a meaningful feature of the statistics, the diagonal pointing upward is a useful symbol.

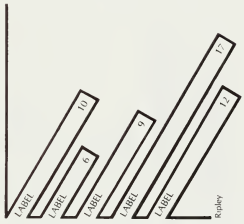
Taking normal columns and slanting them at an unexpected angle creates an image fraught with implications of growth or penetration. Its dynamic force (a combination of the implied symbolism of upward growth at a diagonal angle together with the comparative rarity of its utilization) is capable of creating immediate interest in even the most jaded of viewers.

Here are six examples of the technique.



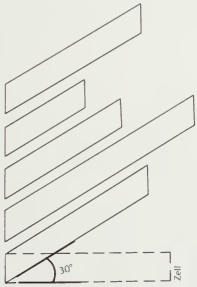
This is no more difficult to draw than the plain vertical column diagram; all you need to do is substitute lines at 60° for the vertical ones.

This is an aggressive image, combining the arrogance of angled bars with a bold background.



A simplified outline of the bars provides an interesting opportunity for labeling at unexpected angles.

A vertical grid overlapped by bars on the diagonal emphasizes the angle, even though the bars are much steeper than those drawn at 60° above.



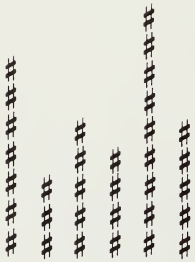
Bars springing from a vertical axis rather than a horizontal axis can also be presented at an angle. This diagram is drawn at 30° from the horizontal.

Combining the normal direction of bars with angled direction can emphasize sudden changes in the statistics. All was normal until a cataclysmic event forced four factors into sudden improvement and the fifth into an equally unexpected decline.

Bars and columns are abstract symbols whose interpretation depends on the way they are labeled; each bar (and its segments) can be described separately or keyed to a color or tint.

A faster and more vivid method of communication results from substituting images for the bars. Such images can be abstract symbols, realistic depictions, or cartoonlike illustrations—your choice depends on the subject of the chart and the context in which it will be viewed. However, any symbols used must be simple and unequivocally clear to all viewers. Furthermore, each symbol ought to represent a whole so that a full row of them can be counted. Fractions of a whole are hard to depict; therefore, this technique ought to be reserved for situations where whole symbols can be used in a majority of the bars.

Here are five examples of pictograms. The possibilities for fascinating presentations in this genre are boundless.



Columns made up of countable, though abstract, symbols.

Columns composed of countable, naturalistic symbols.

Columns of realistic objects shown in photographic form.

Pictograms are most readily understood when the illustrative symbols are arrayed in horizontal bars rather than in columns.

E E E E E E E E E E E E

E E E E E

E E E E E E E E E

E E E E E E E E E E E E E E E

E E E E E E E

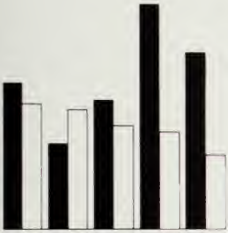
Even typographic symbols can be used as substitutes for pictorial images. Here each *E* represents an elephant, and the chart shows remarkable variations of elephantine populations.

Comparing grouped columns

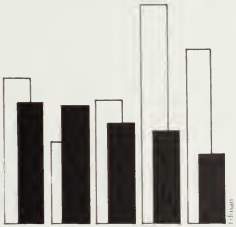
Grouping two or more sets of columns allows us to show sets of statistics related to each other in terms of time, distance, or other logical sequence. It is wise to restrict such comparisons to two sets of data, for more can become confusing. The differentiation has to be effected by subtle variations in draftsmanship: Color, weight, darkness, thickness and thinness of linework are the tools at our disposal.

Columns or bars referring to similar factors need to be placed in close proximity to each other. Often they can even be overlapped. If they are next to each other, then they can be of any length the statistics dictate. If they are overlapped, one set needs to be consistently shorter than the other, lest some of the shorter bars be hidden behind the longer ones.

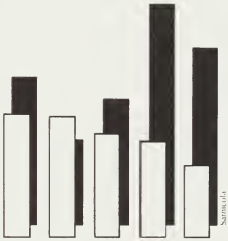
The reader's perception is that overlapping stresses the disparity in length between the bars. Furthermore, the bars or columns in the foreground are deemed to be important, while the ones behind are considered background information.



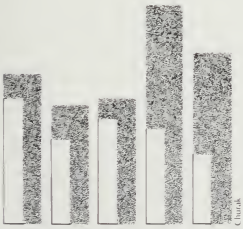
Comparison of data shown in neighboring columns. The two sets are identified by color (i.e., blackness or whiteness), and each couple consists of two butting columns.



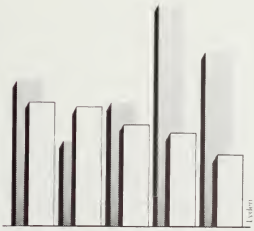
Comparison of data with partial overlap of columns. The black ones are more important by virtue of their position and their stronger color.



Graphically more interesting (if harder to measure in statistical scaling) is this diagram, because the baselines are staggered and the columns are overlapped.



Complete overlap appears to swallow up the white columns within the body of the gray ones.

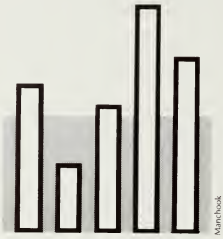


Overlapping in what appears to be three dimensions. The columns seem to be receding into the distance.

Columns viewed from below appear to be as solid; as sculpted three-dimensional units overlapping.

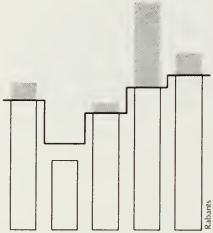
Comparing specifics and trends

Each column in the following diagrams represents some specific fact that needs to be understood by the viewer in a context of background information. That background can be a trend or a constant, but its presence adds drama and meaning to the diagram. Here are four ways to handle such a situation.

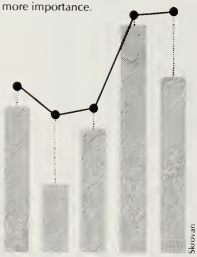


Represent the constant data by means of a tinted background against which the bold columns are to be seen. This rendering clearly implies foreground importance in the columns and background context in the subdued gray tint block.

Use a bold rule to represent the level of the constant. Here the rule is seen to be overlapped by the columns. An alternative — to let the horizontal rule overlap the columns — would give it pride of place and thus more importance.

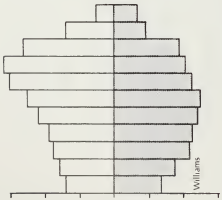


The context — last year's figures — shown as a stepped line; the areas of the columns above the line are tinted for emphasis.



The background or context shown as a "curve"; the columns are related to it by plotting dots along the curve and extending dotted lines from these points to the tops of columns.

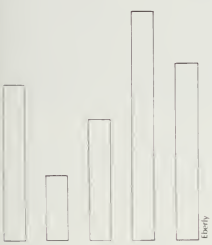
Comparing complex statistics



A standard method of comparing two sets of facts can be seen in the *population pyramid* format: One side of the vertical represents one-half of the population, the other side the other half. Each half is then broken down by age, which is plotted vertically by groups. Clearly, any kind of data that can be broken down into this kind of grouping can be shown in this way.

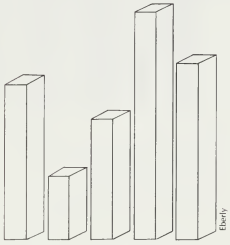
Columns and bars in three dimensions

This graphic technique embellishes the appearance of statistics without in any way altering their accuracy. Furthermore, it is not at all complicated to use, though the result appears impressive indeed. The front face of the columns (or bars) is drawn in the normal manner, perfectly vertical and horizontal.



The original bars drawn flat . . .

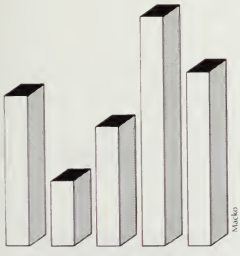
. . . tops and bottoms added at 30° angle . . .



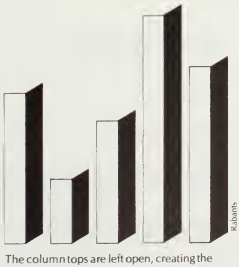
. . . far edges added to complete the columns.

The way an illusion of the third dimension is created is by adding a "side" and a top or bottom to the bar or column, at an angle. The usual angle used for this purpose is 30° (which, with its companion 60° angle, are the basis for standard architectural and engineering drafting techniques). Whether and how the side is blacked in, tinted, or left open affects the viewer's perception of the "solid" object: Its dimensionality is reinforced by the illusion of lighting.

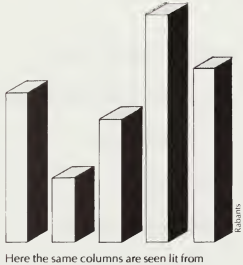
Here are 14 versions of the same set of columns and bars rendered in a variety of three-dimensionalized ways to illustrate the potential of this technique.



Tinting produces the illusion of lighting. Here it appears that the columns are lit from the front.

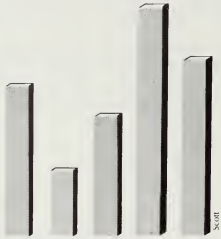


The column tops are left open, creating the effect of glare.

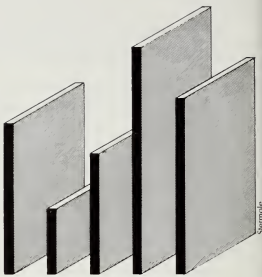


Here the same columns are seen lit from behind, at right.

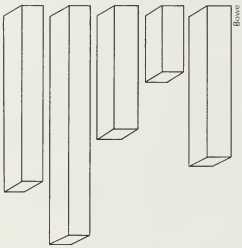
Changing the proportion of the columns changes the way they are interpreted. Here they are deeper, overlapping blocks.



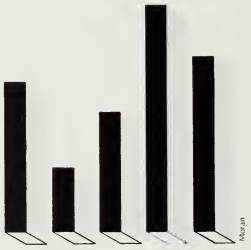
The columns have the same width as the preceding examples, but they have been drawn as shallow planks in the other direction.



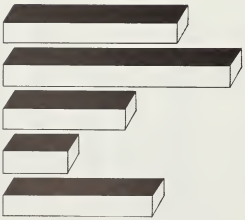
Here the planks of the version at left have been turned around. The fronts are much narrower than before, the sides much deeper.



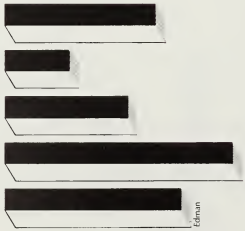
The columns can be viewed from below like stalactites — a dramatic approach to showing data, especially if their negative nature is to be stressed.



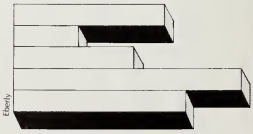
Here the columns are seen from below, but they are easier to compare in terms of the statistics than the stalactites at left.



These columns have been turned sideways and laid on their sides as bars.

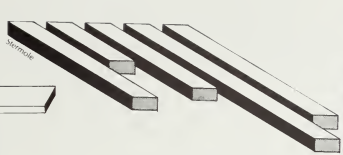


Bars drawn to appear as though they were floating and viewed from below.

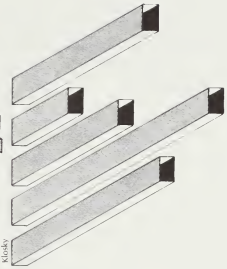


The same bars as those in the diagram at left, stacked into contiguous relationships.

Bars drawn as flat planks lying on a surface; the drafting technique to produce such a diagram is identical to that used on all 14 figures.

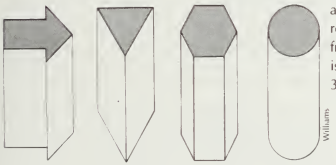


Bars that appear to be advancing toward the viewer, lying flat on a surface, with the horizontal axis in the distance.



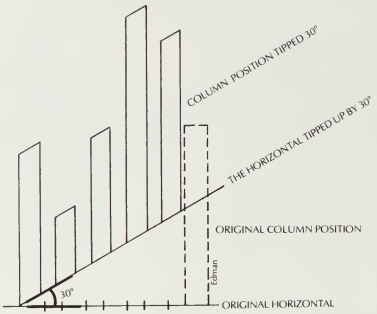
Bars seen from below appear to be advancing toward you. If you turn the book upside down, another effect can be seen: The bars advance toward you, but you are seeing them from above.

The variations on bars and columns so far have been based on the simplest of all shapes: the rectangle. There are, however, no laws to prevent you from using any other shape that might make sense—and possibly even better sense. If the subject happens to be water supply, for instance, then the "bars" ought not to look like rectangular bars. They should look like pipes with circular cross section. Templates for such figures are available ready-made, so you don't have to construct all the shapes repeatedly. All you need do is to plot the position, draw the shape from the template, join the verticals and horizontals, and the figure is complete. It is perhaps even easier than manipulating the 30°/60° triangle.

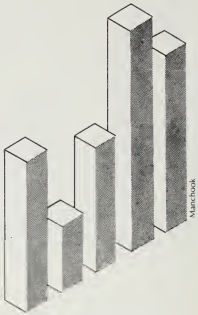


Bars at an angle

Charts are no more difficult to set up at an angle than head-on. All you need to do is to tip the baseline while keeping the verticals vertical. You then draw in the "third dimension" at the same angle at which the baseline is tipped. The usual angle is 30° because it is the simplest and most effective and thus most widely used. It happens also to be the angle at which a cube's three sides can be drawn equally long—which only happens when you look down the cube's diagonal; all the angles are related to 30°. The commonly used technical term is *isometric projection*. There is a far more mundane reason for using the 30° angle: You can buy 30°/60° triangles very easily, and they are simple to use. For any other angles (other than 45°, for which ready-made triangles can also be bought) you need an adjustable triangle, which is an expensive and tricky tool to use.

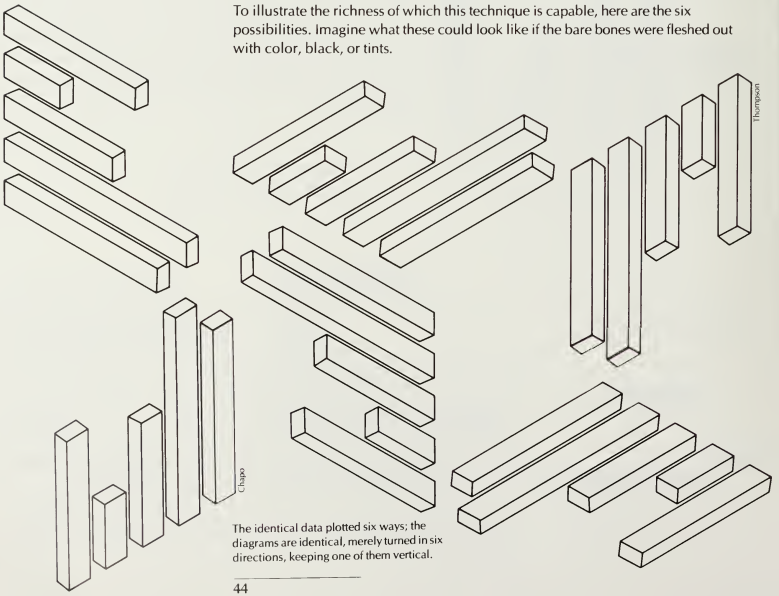


To construct a column chart at an angle, simply tip the baseline the requisite direction and continue as though the lines at an angle were the normal horizontals, but draw them at the required angle.



All the techniques of three-dimensionalization shown on the preceding pages are applicable to this variation of the column and bar format.

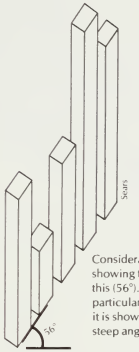
One of the directions of the lines must be vertical, or else the whole diagram will look wrong. Which set should it be? That's where the fascination lies, because you can tip any diagram six different ways. (That is the nature of hexagonal isometric projection.) To illustrate the richness of which this technique is capable, here are the six possibilities. Imagine what these could look like if the bare bones were fleshed out with color, black, or tints.



The identical data plotted six ways; the diagrams are identical, merely turned in six directions, keeping one of them vertical.

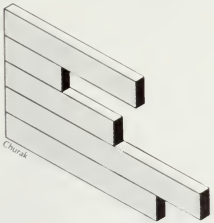
To illustrate the effect of changing the angle from the usual 30°, here are two versions of the same data plotted at 20° (left) and 56° (right). Why those angles? There is no rationale other than the desire to show a "shallower" and a "steeper" rendering.

A 20° angle results in a diagram whose shapes appear to sit on the page in a natural, comfortable way — more so than those at 30° (shown previously).



Considerable drama is engendered by showing the data at a steep angle such as this (56°). There is no reason to use this particular angle as compared to any other; it is shown merely as typical of the effect steep angles can produce.

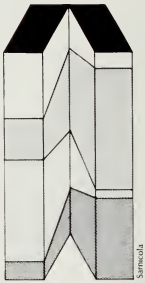
A much more striking graphic effect is created by bringing the columns into close proximity or even making them touch. Such touching, however, can be misleading, for it implies relationships other than those implied by simple, self-contained, individual columns (see page 33). However, from the point of view of plain graphics, these "walls" of columns can be great fun.



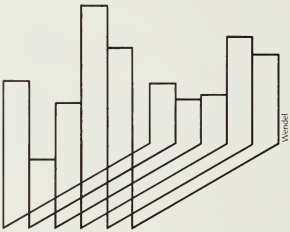
Two illustrations of bar/column charts whose bars/columns are touching; they are, strictly speaking, histograms. Drawn at an angle and three-dimensionalized into planes with shaded sides, they are dramatic, interesting-looking objects.

Comparing grouped bars in three dimensions

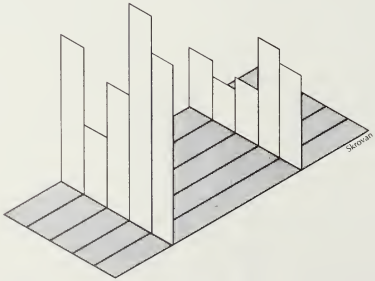
The illusion of the third dimension allows for far more interesting diagrams than the rather simple ones seen on page 39. In those cases the comparison was between individual couplets of data. Here more complex relationships among groups are the basis for this graphic presentation. The degree of elaboration has been kept deliberately simple, in order to illustrate the principle underlying the graphics. Common sense and an understanding of the context and the audience must dictate the limits to which you should go. A word of warning, however: There is so much fascination in constructing these figures that they can become will-o'-the-wisps, leading you on to exaggerations not warranted by the material or its importance to the story.



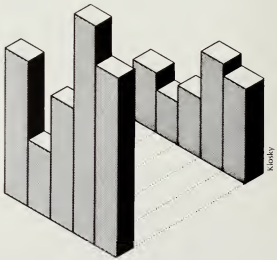
Comparison of the data embodied in two columns (each of which is 100 percent) with connecting planes that show trends.



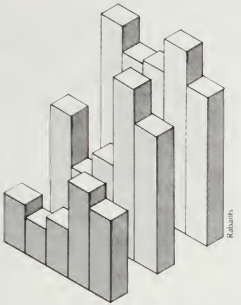
Two sets of figures rendered as seemingly transparent planes joined in space.



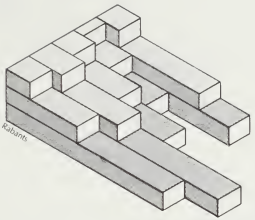
The same data shown in the preceding example, plotted here as opaque planes at a 30° angle. The baselines are extended into a plane whose divisions create a pattern emphasized by a gray tint. The contrast of the white vertical walls standing on a gray ground is the reason for the cheerfulness the diagram communicates.



The information contained in the diagram is, again, identical to that at left. Here, however, the effect is one of much greater solidity, "blockiness," permanence. Its assertiveness is due to the heaviness of the shapes as well as their dark tinting.



A series of three sets of columns reminiscent of cityscapes. The tinting helps to create the illusion of receding into the distance, because the planes become paler the farther they are from the viewer.



Building pyramids from layers of bars is possible if the numbers to be plotted decrease as you build upward. Care and accuracy are essential ingredients in any attempt to construct figures of this complexity.

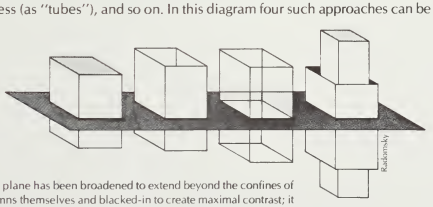
Sliding columns in three dimensions

Great drama and interest can be derived by taking the sliding columns and bars shown on page 35 and making them three-dimensional with the techniques described on pages 41–46. The entire construction is based on visualizing the baseline or datum level as a plane rather than as a simple horizontal line.

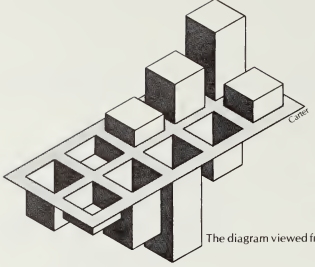
The simple diagram:
The baseline, above and beneath which the data are plotted, is a horizontal line.

The three-dimensionalized diagram:
The baseline has been flattened into a plane, the columns built as solid shapes protruding above and below it.

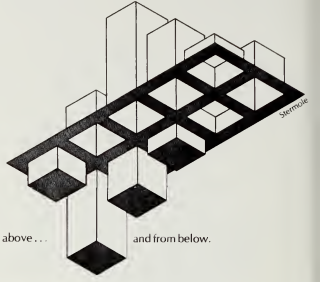
The columns are set up in normal fashion on the plane and then given the illusion of depth. Any number of variations can be brought to this theme, not merely in surface coloration, but also in rendering the columns in terms of their solidity, transparency, emptiness (as "tubes"), and so on. In this diagram four such approaches can be seen.



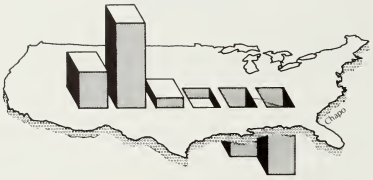
The base plane has been broadened to extend beyond the confines of the columns themselves and blacked-in to create maximal contrast; it forms a good background for "solid," "tubelike," "transparent," and complex columns.



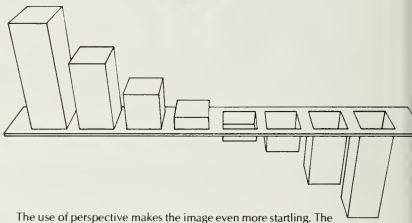
The diagram viewed from above . . .



and from below.



The base plane can add meaning to the diagram if it is turned into a picture, such as this map.



The use of perspective makes the image even more startling. The technique of setting up perspectives is discussed on the following pages.

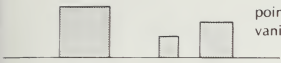
Bars drawn in perspective

Columns and bars —all diagrammatic forms, in fact —look artificial if they have that geometric appearance they get from their graphic construction; the lines are parallel (all vertical or horizontal) and all the angles are the same (30°, 60°, 45°, or whatever other angle you may have chosen). That gives them an artificiality that is acceptable in diagrams, which are, after all, artificial constructions based on quantifiable data and turned into visual forms to scale.

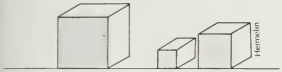
The natural world —the one we look at when we aren't poring over statistics — doesn't look that way. It has a dimension of depth that we perceive as such because objects appear to diminish in size the farther from the viewer they are. (If we were discussing painting, we would also note the fact that objects become paler and their color changes to bluer hues as they recede in distance. But here we are talking about factors that are essentially monochromatic, so we can shelve that insight. It may, however, come in handy when we need to decide how to tint planes that recede, when we have several such overlapping planes in a diagram.)

The principle of perspective was pioneered by Giotto in fourteenth-century Italy. Giotto figured out how to construct a drawing before applying paint so that the illusion of depth and distance would be accurately depicted in two dimensions in the picture. He also discovered (or at least articulated for posterity) the principle of the "vanishing

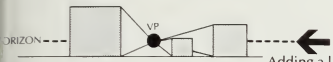
point'' —the point at which all lines seem to converge on the horizon. (The vanishing point is called ''VP'' in technical parlance.)



Three blocks sitting on a baseline in a two-dimensional rendering.



The same blocks rendered three-dimensionally by adding a set of ''sides'' at 30° angles.



Adding a line at eye level or ''Pix'' (here shown dashed) and placing a vanishing point on it in an arbitrary position allow us to connect the three blocks to a single point. Now we have three beams disappearing into a point in space.

The horizon line can be placed anywhere you want it, and the vanishing point can be placed anywhere you like on that horizon line. The variety of effects this choice creates is startling. Here are examples to illustrate the principle.

Horizon close to the baseline, VP at far left.

Horizon farther away from the baseline, VP at far right. The horizon is high enough to enable you to show the tops of the two smaller blocks, but low enough not to reveal the top of the tall one at left.

Here the horizon is in the area above the blocks; the VP is located near the center.

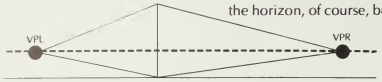
Here the horizon coincides with the baseline, the VP is near the center. This special placement of the horizon results in an image of grandeur.

By lopping off the beams and shortening them into cubes, you transform them into three-dimensionalized blocks neatly arrayed in a line.

The baseline connecting the front planes of the three blocks is, in fact, merely the point along the ''floor'' at which the *picture plane* happens to intersect. The picture plane is a vertical plane we imagine as being the closest point of the image we are looking at. In the diagrams above, all three blocks (be they beams disappearing into the distance or cubes) touch it with their fronts. That's why we interpret the diagram as saying that the three are in a neat row. If one of them were to be removed from the baseline (i.e., the picture plane), it would appear to have jumped back into the space between the picture plane and the vanishing point.

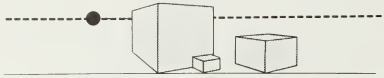
The block at left touches the baseline, which is the picture plane in this diagram. The two smaller blocks do not; they have been moved up from that baseline. The effect is interpreted by the viewer as implying distance —the smaller one being much farther away than the larger one.

If the object we are looking at is not parallel to the way we stand but is placed at an angle to our direct line of view, there have to be two vanishing points. They are both on the horizon, of course, but all lines now converge to either one or the other.

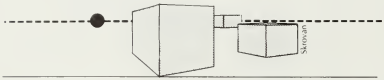


Two vanishing points are required to show an object standing at an angle to the baseline or picture plane.

Here are the same three cubes, this time touching the baseline only with their front corners. Their sides must be drawn to disappear to the left or to the right (VPL, VPR).

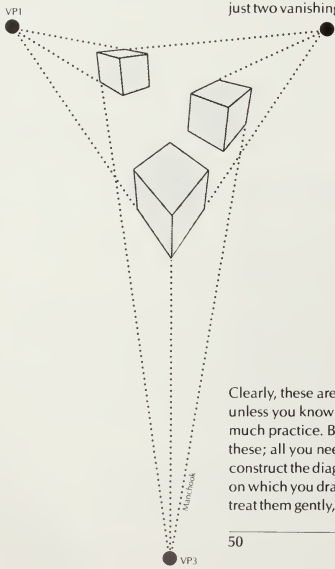


As with the one-point perspectives, you can achieve any effect you want by choosing where to place the horizon and the two vanishing points. This is merely one version to illustrate the point. Compare the effect of this diagram with the one directly above.



Again, as with one-point perspectives, you can create the illusion of objects placed in space by lifting them up off the baseline and moving them "back" from the picture plane.

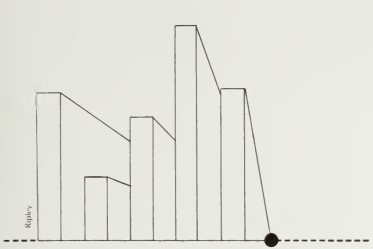
What happens when we decide to fly up into the air and look down at the view? We complicate the construction by one more degree, because now our blocks don't need just two vanishing points but a third one at which the vertical lines converge. Without this third VP, the illusion of depth looks unreal. By the same token, if you decide to look up at the objects, the third vanishing point has to be somewhere in the sky.



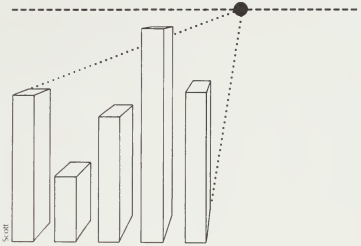
Three vanishing points are required for constructing a three-point perspective — whenever the viewer is looking down or up at the subject. The accepted technical terms for such delineations are *bird's-eye view* and *worm's-eye view* (for obvious reasons).

Clearly, these are tricky constructions, and it is unwise to attempt them from scratch unless you know what you are doing. Like haute cuisine, they require deftness and much practice. But you don't have to be a master draftsman to make diagrams like these; all you need to do is buy some perspective grids at the art supply shop and construct the diagram on them. You use them as patterns underneath the tracing paper on which you draw. They are not inexpensive, but they are a lifetime investment if you treat them gently, and you never know when they might come in handy for that special

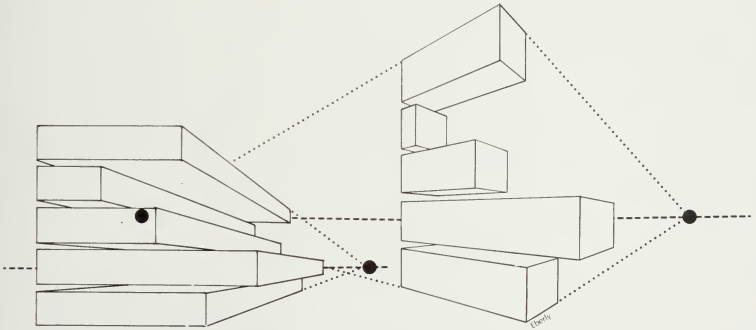
effect you need. As inspiration, and to whet your appetite for doing diagrams in perspective, here are a few examples. Some grids can be seen on page 188.



These columns (seen elsewhere in this chapter) are here rendered as slabs in space. Their sides are shown as vanishing to a point that happens to be on the baseline.



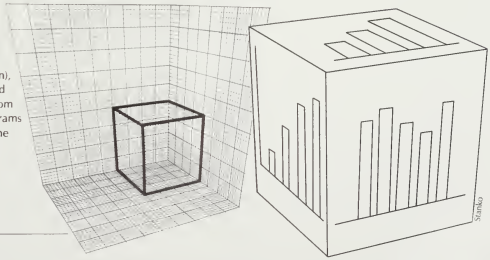
The same columns here are joined to a vanishing point on a horizon line well above the highest column. That is why we feel as if we were floating in space above the columns, looking down at their roofs.



The same columns are here laid sideways to form bars, seen vanishing toward a point almost halfway up the stack.

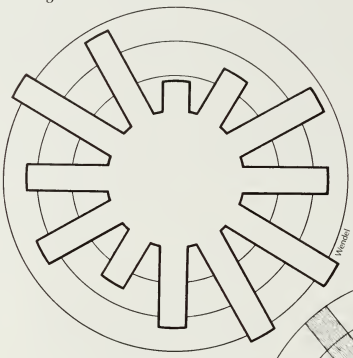
This two-point perspective of bars stacked sideways uses two vanishing points. Turn the book around to see the effect of this diagram from other directions. Looking at it as it is printed, it is relatively tame. Turned sideways, the bars seem to be advancing at you in the most dramatic manner.

An example of three-point perspective: This box was constructed on a perspective grid sheet. Note that none of the lines is parallel. Though we think of the vertical edges of the box as being vertical (i.e., perpendicular to the horizon), they are not. They are drawn at an angle connected to a vanishing point some sixteen inches down from the lowest corner of the cube. Naturally, the diagrams imposed on each facet of the cube must follow the same directions in order to make them appear as though drawn on the cube itself.

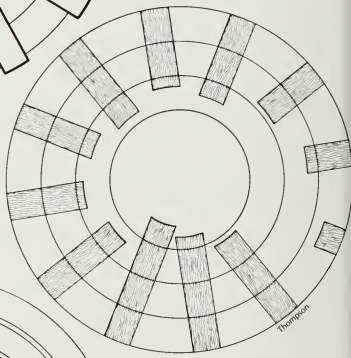


Bars in circles

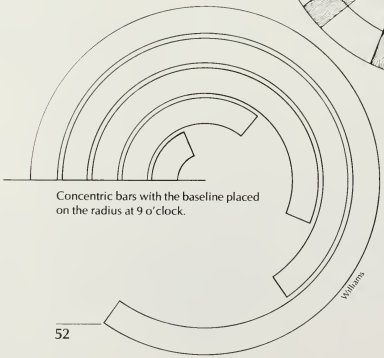
There is no law that stipulates that a field must be flat and rectangular, even if the rectangle is the clearest and the most conventional way of presenting facts. We can make the field any shape deemed appropriate. Here are three charts based on the circle. They are obviously rather specialized shapes, but they can be useful, given the right circumstances.



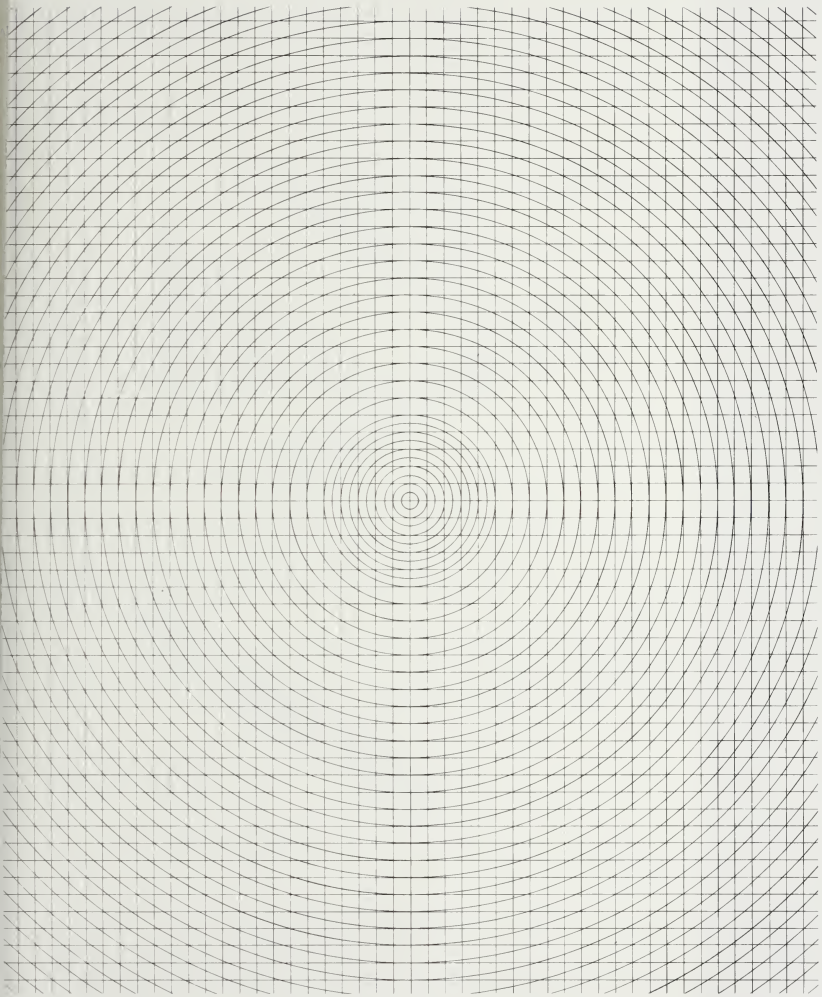
Bars growing out from the center, with the inner circle as baseline.



Bars growing inward toward the center, with the outermost circle as the baseline.



Concentric bars with the baseline placed on the radius at 9 o'clock.

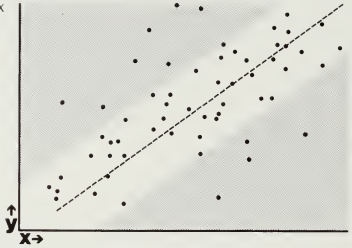


4: DOT CHARTS

■ There is good reason why this specialized group of charts is referred to as *scatter diagrams*. They derive their character from the fact that situations often occur where a multitude of plotted factors do not appear to fall into specific, clearly defined patterns. They are scattered indeed.

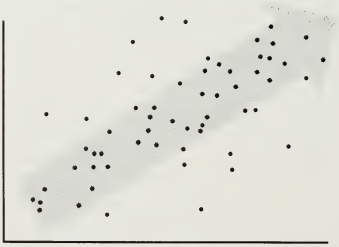
If these facts are merely reported as mathematical statistics, any semblance of trends or averages becomes practically impossible to deduce. However, if those same facts are plotted on paper, such hidden trends may well pop out at you from the paper.

Raw statistical facts plotted against the X and Y axes. They do not appear to have much relationship or patterning.



In the diagram you can see a number of random facts plotted in the conventional way. They are apparently unrelated to each other, and so little purpose would be served in trying to join them with a single unifying line. However, by noting the clustering of the dots, a basic trend or direction in the group as a whole can be discerned. It is possible to point up a trend by superimposing a broad swath of tint over the area; to add emphasis, it might be helpful to tack an arrowhead onto the top end of the swath.

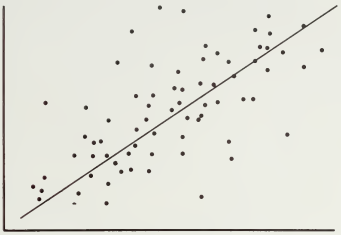
The plotted dots represent the "actual" or raw data. Here they are combined in such a way that a conclusion can be drawn from their relationship, which can be thought of as the "result" (or, if you are trying to prove something you knew beforehand, it can be thought of as the "expected").



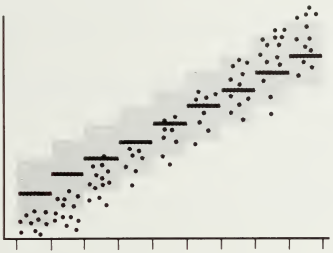
A dot chart can, therefore, be used for two distinct purposes: (1) to help find a pattern, if there is one; and (2) to help prove a pattern you knew was there.

When a trend is visible, it may be useful to show how far specific items deviate from the average or the norm. There are two basic ways of illustrating this graphically (although each situation may well call for a variation of the ones shown here):

The dots show individual facts; the trend is defined by the wide swath; the mean is indicated by the centerline.



The dots show individual facts. Each vertical segment or grouping is plotted separately; here they appear as floating columns. The median is indicated as a horizontal line within each column, and a comparison can be made between the dots in each segment and their relation to the dividing line. The dividing line represents the median; the top of each column means "over," and the bottom means "under," expected limits.



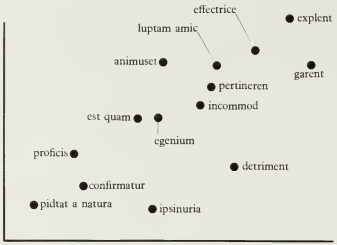
Graphic variations

There is no reason why dots must be round, though they are the most commonly used. You can use shapes such as these ■ □ ▼ ▽ ● ○ ✕ ✓ ⇕ or any others you might prefer as being evocative of the subject. Such symbols are available in rub-off or self-adhesive form, as well as in many software packages. Given this added capacity for variation, it may be useful to differentiate your raw statistics by subject and represent each subject with a different kind of "dot":

Dot shapes can be used to differentiate or classify the subjects they represent.

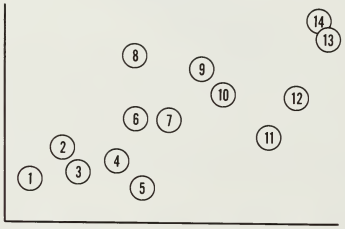
Such differentiation of subject may be improved by actually labeling each dot, if there is room:

The labels for the dots here are, of course, nonsense words. It is worth noting, however, how human curiosity forces us to try to read verbal labels of this kind.



Should there not be enough room for comfortable labeling of each dot by name, there may be enough room to make the circles large enough so that a number can be placed within each circle:

A clear picture of the substance of this chart could be quickly communicated by informing the reader that dots 1 through 7 refer to such-and-such a factor, numbers 8 and 9 to another, and 10 and up still another.

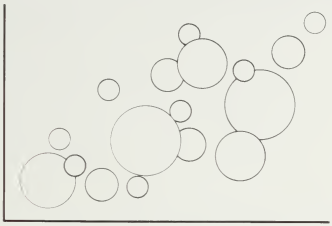


A less satisfactory solution is to number each dot outside (next to) the black mark. It is less satisfactory only because the numerals themselves look like dots. A clear picture of trends is thereby camouflaged.

Differentiating between the dots (circular or of other shapes) and the numerals is not an easy task: They tend to combine into a mixed pattern. The previous figure is far easier to read, but it is less accurate; for it is more difficult to find the precise center of a large circle. The smaller dots here pinpoint the data more cleanly.

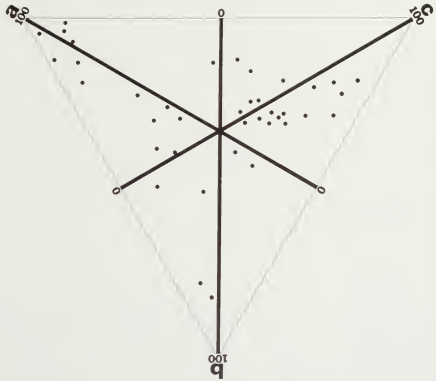
A further improvement on techniques for reporting facts and making them more accessible is to represent value with corresponding dot sizes: The more important the fact (in numerical or any other term), the bigger the dot that represents it.

Large bubbles stand for large numbers or values, smaller ones for smaller numbers or values. Clearly, problems of accuracy in plotting will be encountered. One possible solution is to allow the bubbles to overlap, as here. Only trial and error will determine whether this technique is appropriate for any specific set of facts. Too much overlapping may destroy the clarity you seek.



The field on which the data are plotted can also be expanded to accommodate more complex relationships. All of the examples shown so far have been based on the most primitive of plottings: one to one, vertical to horizontal. There is no reason why the field should not take a different shape. Why, for instance, can't it have the shape of an equilateral triangle, in which each of the three apexes represents a maximum of three related factors, and why can't the dots be placed on scales that lead from those maxima to minima at the midpoint of the opposite side of the triangle? The answer to this rhetorical question is seen in the accompanying drawing—and it is an unequivocal

Each apex represents the maximum value of one factor. The midpoint of the opposite side becomes the minimum value of the same factor. Plotting the interplay of three such sets of data can be a most fascinating presentation, leading to fresh insights . . . or it can be so hard to understand that the viewer may not even try.



"yes and no." Yes, there is absolutely no reason why that is not a logical representation of three interrelated sets of factors; no, because it looks dreadfully complicated. Since the true purpose of making diagrams is to communicate faster and more vividly, we must guard against becoming so fascinated with the *process* that we make the figures more complicated than their subject.

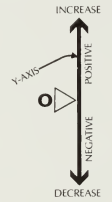
5: CURVE AND SURFACE CHARTS

■ This group of formats offers as rich a variety as do column and bar charts — and it encompasses a variety that goes beyond the standard clichés everyone learned about at school. And, just as with bars and columns, it is difficult to divide this subject into logical segments that build one on the other. However, graphs possess the special attribute of being visual as well as verbal. In fact, scanning through pictures is probably a faster way of finding what you are looking for than following a verbal analysis.

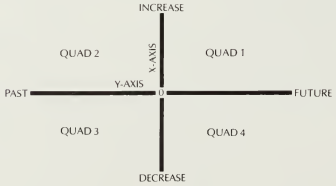
Time is the operative word in graphs, as the two subdivisions, curve and surface charts, are called. Graphs are ideally suited to showing time as reflected in the development of an idea, in changes occurring in a sequence over a given period, or in the visible improvement or deterioration of a situation over a series of stages.

Time is universally understood to flow from left to right, so it is plotted on the horizontal (*X*) axis. The past is to the left, the future to the right.

Quantity or amount is tied to the vertical (*Y*) axis. The accepted convention places zero (0) on the time line, so that an increase is shown as starting on the intersection of the *X* and *Y* axes and moving upward; decrease is indicated by movement downward from zero.



The basic graphing field can be broken down into four quadrants.



Usually only Quad 1 is used, unless negative values need to be plotted, in which case any of the other quadrants may be added to the chart to include the requisite data.

Facts are plotted on a graph by finding the point at which the vertical numbers intersect the horizontal ones and placing a small dot there. Once the dots are in place and you can see a pattern evolving, you can decide how best to communicate the pattern in the diagram. This is where the interpretation of the thrust of the diagram comes in: What is its purpose? What are you really trying to say about these numbers and their relationship? What is their significance to the viewer? What do the numbers mean to the subject being reported on? How can the diagram contribute to bringing the significance of the data into focus for the viewer?

Differences between curve and surface charts

The fundamental decision will be whether to use a curve chart or a surface chart. They are similar, since they are plotted identically. Yet they are quite different after they have been rendered.

The *curve chart* (also often called *line chart* or *line graph*) joins the plotted dots with a line. That line, which can be a series of straight lines or a smooth curve, emphasizes motion or change by the very fact that it is a line. As such, it highlights trends; by its steepness or shallowness it brings attention to the *rate of change*—the steeper the line, the faster and more dramatic the development appears to be over time.

The *surface chart* starts out with the identical plotting of dots. But, instead of joining them with a line that is visible as such in the final artwork, that line on a surface chart becomes the topmost edge of a colored area. (Of course, the "color" can be black or gray.) What is important to the viewer, then, is not the line, but rather the area between the line and the horizontal axis—the *surface*—that is inked in to give it visibility. What is perceived by the viewer, then, is the *amount of change* at any point in the diagram.*

Your decision, therefore, boils down to this simple question: Do you prefer to emphasize trends as a result of changes, or do you wish to highlight the quantities represented by those changes?

Trends—quantities are background information

Quantities—trends are background information

*This is very similar to step charts, which are a variant of the column chart format (see page 33). Step charts are those in which the columns touch each other. In step charts, the tops of the columns are flat, implying that a level remains steady until the next sudden change occurs in time. In surface charts, the tops are angled and change directions smoothly over the time periods indicated. In effect, surface charts may be thought of as step charts with the added virtue of showing trends.

Curve and surface charts have their own distinct advantages; you should be aware of them before you make your final decision:

1. The surface chart can make the most of simple facts; it makes data appear to say more because of the nature of the graphic image itself. An area of color has more dignity than a scrawny, wavy line. That is why it looks richer and somehow more important.

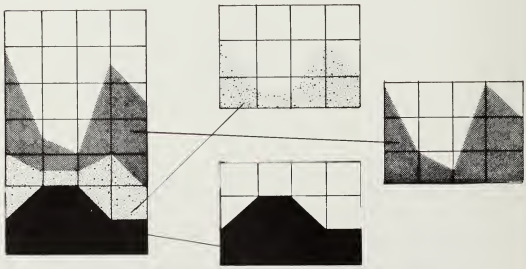
2. The surface chart lends itself to more flamboyant graphic treatment because the shaded area offers more opportunity for variety, texture, and enrichment.

3. The curve chart allows you to compare several lines, even if they overlap. A surface chart does not permit such comparisons without great difficulty.

4. The curve chart lets you bridge gaps in information by continuing the trend line from one known point to the next known point. Therefore, it can be extended logically to show forecasted trends. A surface chart, by comparison, seems to be so much more solid that such guesstimation seems inappropriate to its form.

5. Both curve and surface charts can be compressed into tiny areas, yet both will maintain accuracy of information (if general trends and data are to be discerned).

6. A surface chart can easily mislead the viewer to confused or even wrong interpretation when more than one "layer" of information is shown, because it is difficult to compare data precisely. The lowest layer, built on the horizontal, allows for easy deductions of changes over time. Subsequent layers must then be added atop the roof of the first layer, with the result that their "zero" line is not flat, but rather follows the rambling top of the previous layer. Therefore, only vague impressions of growth or diminution can be had from such an image. If you must show precise, measurable comparisons, it might be best to use a column chart or, better yet, to break up the series of layers into individual images keyed to a master comparison chart. That way you get the best of both worlds.



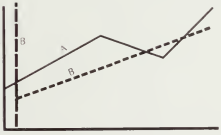
The curve chart avoids such problems of misunderstanding because it is obvious that each individual curve describes a specific distance from the axes. The surface chart can be interpreted as describing the distance from one edge to the next edge above it.

Axes

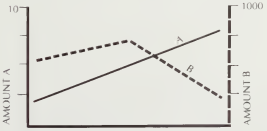
The conventional definitions and accepted nomenclature for the axes were discussed on page 58. Following from that, it is safe to say that their normal, and thus expected, positions are as follows:

But you don't have to adhere to this convention. If you want to call attention to the end of the sequence—the *result* of the plotted data—then it is better to place the vertical axis at the right-hand edge of the diagram and have the curve end there. That way nobody can miss the significance of the data.

It is also perfectly acceptable to have a set of dual vertical axes. If they are doubled up on one side or the other, there may be a bit of confusion, unless you use a different color to distinguish one vertical axis (and the curve to which it refers) from the other.

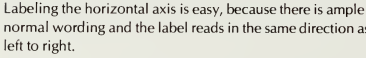


It is better to put the two vertical axes at opposite ends of the diagram, because then you create a clearer picture of the two separate sets of data being compared. It is wise, incidentally, to doctor the vertical scales in such a way that they both start at the same level (zero) and end up at the same level on top.

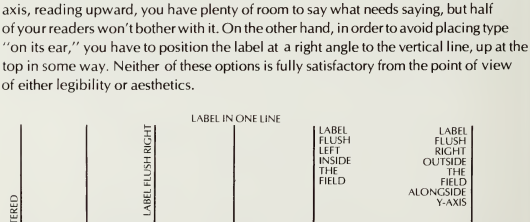


It is also possible to go against the expectations of the viewer and make your own rules. Here is an example of that approach. One vertical (amount) axis is being compared to two horizontal (time) axes. The time axis at left works well, but the time axis at right must be perceived as running backward from right to left. There is some risk in using this technique, for it assumes that the viewer will make that switch in thinking. Where the two axes meet is the point of origin (zero) for both directions. It needs to be labeled clearly.*

Labeling the horizontal axis is easy, because there is ample room to accommodate normal wording and the label reads in the same direction as the time scale: left to right.



Alas, labeling the vertical axis is always a problem. If you run it vertically alongside the axis, reading upward, you have plenty of room to say what needs saying, but half of your readers won't bother with it. On the other hand, in order to avoid placing type "on its ear," you have to position the label at a right angle to the vertical line, up at the top in some way. Neither of these options is fully satisfactory from the point of view of either legibility or aesthetics.



*All labeling should be clear and easy to read. If it is there at all, it is there for a purpose. Alas, chartmakers try to make an image "clean" and, in order to do so, they err on the side of smallness of lettering. The purpose of any diagram is to communicate its information lucidly, succinctly, and quickly — without asking the viewer to puzzle it out. A crucial ingredient for success is to make the lettering large enough to be read as easily as the type of the surrounding text. It is the text type that gives the reader a sense of scale, and it is against this scale that the chartmaker must measure the lettering in the charts.

Plotting the dots

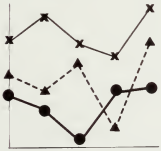
To start with, plot points on the graph with small dots, in order to make the chart. In the final diagram, you have the option of making them disappear (using them as the tips of the angles—the nodes where connecting lines meet) or showing them as features of the curve.

Which approach should you choose? Here the purpose of the chart ought to give you the best clues. If your main reason for using the chart is to show a trend, then you want to emphasize the flow as smoothly as possible. It follows that any individual points along the line would interrupt that smoothness. So you erase the dots.

If the specific data are of the essence, then it is advantageous to emphasize the numbers—the positions on the field—in which case using the dots becomes not merely a valid technique but, indeed, an essential means of communication. How you render them, then, becomes the fun part of the decision-making process. Here are three examples.

There is no reason why only dots should be used. You can use any symbol you like, but these are the most common. □ ■ ▽ ▲ ✖ ◉
They are easily accessible and can be bought in art supply stores as transfer art or as prewaxed cutouts in sheet form. They come in a variety of sizes.

The need for such variety of symbols arises when several curves, plotted on the same diagram, must be distinguished from each other. The symbols, as well as the pattern of the lines, then become the distinguishing features.

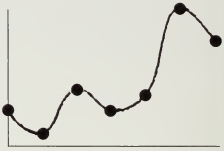


Lines or "curves"

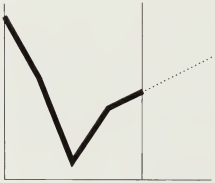
Although we normally join the plotted dots with straight lines, it is sometimes preferable to join those points with curved ones instead. The viewer may be persuaded by our facts more vividly if the flow of information follows a smoothly curved rather than a jagged path. But drawing such curves is only easy when the plotting points are closely spaced; when they are farther apart, bridging the gaps between them with smooth, right-looking curves requires considerable finesse. It is still something that can only be done well on paper. Until cathode-ray tube resolutions become much finer, subtle curvatures will continue to look jagged.

The plotting points must define the apogee and perigee of each curve, because otherwise false information could be communicated. The more accurate the curve is, the more credible the chart will be. Curved lines between plotting points add such credibility, because development over time—which is what is being plotted—

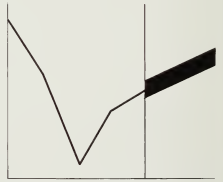
usually involves a gradual process of change, which is not accurately represented when it is drawn in zigzag lines. Often, curves are the true representation of facts, and for that reason they are well worth the trouble to plot on a chart.



When a chart is carefully delineated, it becomes possible to present a future projection that is as credible as the picture of past performance shown on the diagram. When projections are needed, they are often the culmination of the chart—the past is prologue. Yet it is accepted practice to make that part of the chart paler by drawing the lines dotted, dashed, tinted, or in texture or color. However, if the projection is indeed the crucial element, then start out with it. Make it dominant, and shape the supporting infrastructure to its purposes.



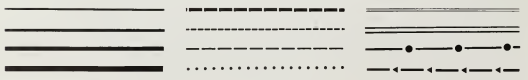
Weak statement of future projection reflecting diffidence.



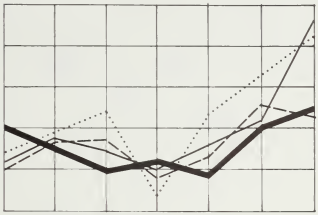
Strong statement of future projection bespeaking confidence.

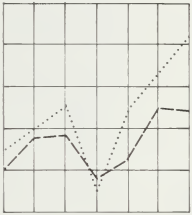
In diagrams that have merely one plotted line, the fatter it is drawn, the stronger will its visual impact be. There is a drawback however, for a fat line can be perceived to be less accurate. The finer the line, the more precisely it can follow the plotted points. Your choice between these two extremes must be based on what the chart is intended to accomplish, what it is about. Should it give a general impression to make a splash, or should it be a scientific depiction of crucially subtle data?

In diagrams with more than one line, the most important line needs to be given dominance through weight or color. In single-color reproduction, it needs to be the fattest line. In multicolor reproduction, it must be the brightest color. Other lines must be distinguished from it and from each other by the character of the draftsmanship. Such differentiation can be achieved by varying the thickness of the lines, using a different pattern of dashes, or by combining the lines with a variety of dot patterns. Here are some typical patternings. They can be hand drawn or attached to the drawing from rub-off transfer sheets or cutout adhesive sheets.



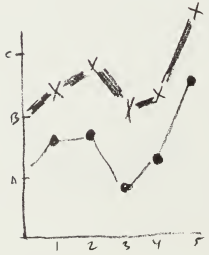
In diagrams where there are so many overlapping lines that even the most careful draftsmanship still results in a plate of spaghetti, there is nothing for it but to halve the portions and present them on two, more palatable dishes instead.



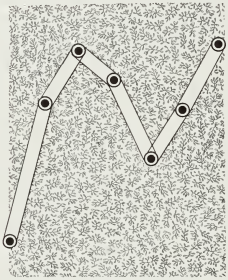


Graphic enrichment of simple charts

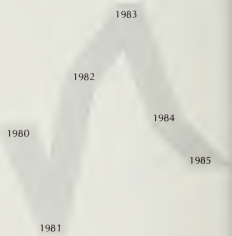
If you expect the curve chart to be uninspiring, it will be. Your expectations are a self-fulfilling prophecy. To spark ideas, as well as to prove that a simple curve chart need not be the pedestrian image it normally is, here is a group of such diagrams. It is inserted here in the flow of the thinking of the chapter for a very important reason: The technique of graphic presentation that you are likely to choose — because it is appropriate to the subject, as well as to the audience — is as important a factor in early planning as understanding the subtleties of axes, lines, and dot formation. It is, perhaps, a little more esoteric, dealing with more aesthetic aspects than technical ones; however, those aspects are probably more important to the final result because those are the qualities of human contact on which successful communication of ideas must be founded. The draftsmanship, the presentation, the cleverness of imaging are the tools that make the viewer *want* to look.



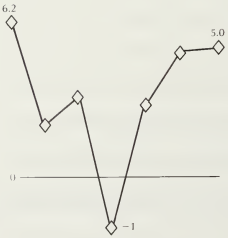
Sketchy, off-the-cuff and on-the-napkin draftsmanship symbolizes first ideas, tentative solutions to problems, sudden insights.



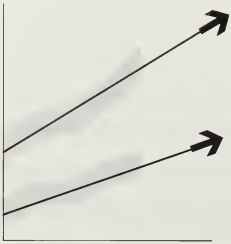
Highly accurately plotted points seen as elements of a wide line of evident importance. The decorative background could be wallpaper. Is the subject referring to domestic matters, perhaps?



The years (i.e., times of change) are so important that they are shown as the pivotal elements influencing the development of the line.



Mark the figures on the line itself to make the job of understanding the data easier. The axes thus become unnecessary. The viewer will assume that the plotting points have been placed in accurate relationship to each other.

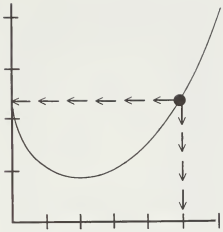


The trend is emphasized by the centerlines drawn within the curves. Projections are signaled by the abrupt ending of the curves as well as by the pointing arrows.

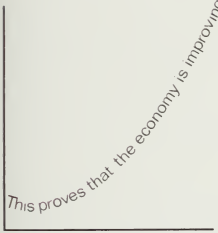
The curve is drawn as an arrow, making it clear that the purpose of the diagram is to stress the flow of change. Furthermore, the arrow points toward the vertical axis, thus bringing the viewer's eye to what is important: the results of the flow.

The curve appears to cast a shadow onto the background. The interpretation of such a trick depends on circumstances and subject.

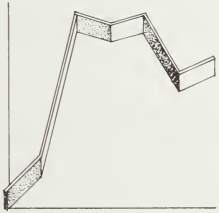
Symbolic graphics represent the plotting points. If the subject is meant to be illustrated by bouncing or rebounding, then allowing the first ball (at left) to enter the figure by overlapping the axis and the last ball to bump into the right-hand edge of the frame emphasizes the idea of motion.



An effective way to bring attention to a significant point on the curve is to point an arrow to it. If, however, a string of such arrows can lead from the curve point to the two axes, the viewer's eye can be led consciously to the significant figures as well.



The curve is made up of words—not the easiest of images to plot out neatly, but what a fast means of communication! The medium is, indeed, the message here.

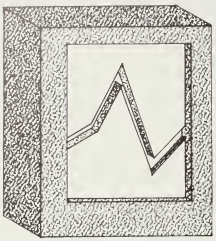


The curve is drawn as a wall.

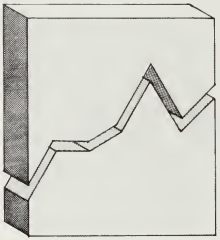
You can add human interest to dry statistics with pictures of the subject matter.

Combining the curve with a photo allows the viewer to understand the context of the curve's subject at first glance.

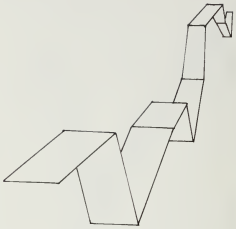
Superimposing the curve over an illustration with symbolic meaning helps to move the statistics out of a purely mathematical context and into one that interests and involves the viewer personally.



A line carved from a block gives the image an aura of immutable permanence. The face of the block is the field, with the axes incised thereon.

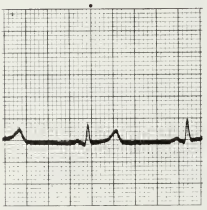


A simple variant on the block scheme is to make the curve a "gap" between two split parts of the block, whose edges are understood as being the axes.



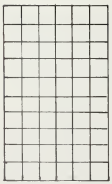
Adding the third dimension to curves can open up an unlimited spectrum of graphic possibilities.

Field or background



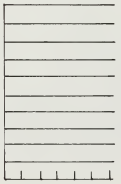
Although it is possible to communicate general trends in a single, flowing line such as this  it is usually necessary to place the line on a background or field in order to indicate the context to which the data refer. Since it is essential to have a field to work on in setting up curves correctly, the one question that remains is how that background is to be presented to the viewer. That, in turn, depends on how much detail is necessary to make the statistics intelligible. Obviously, where minute variations are critical (in cardiograms, for instance), there is no choice: You have to show the full graph paper background or else lose the reference points that are essential to a proper interpretation of the results. On the other hand, it may well suffice to show only the horizontal axis as reference point if just a broad trend is to be indicated.

The secret is to use only that background that will be useful, leaving everything else out. Only then can you make certain that the important information—the lines or the surfaces in the foreground—pops out at the viewer at first glance.

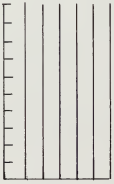


You can show the whole grid,

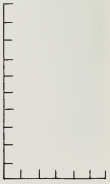
partial grid,



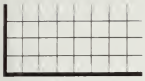
horizontal lines only,



vertical lines only,

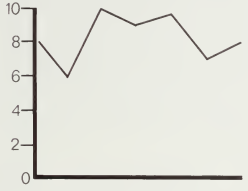


or just tick marks.



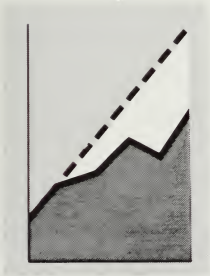
It is a good idea to make the grid lines light, so they don't conflict with the curves drawn over them; however, the axes can be drawn bolder for dramatic contrast.

Should an area of the background remain unused, it is accepted practice to "break" the background, thus allowing that portion of the data you wish to highlight to expand. That way details can be shown larger and with greater clarity. This does, of course, exact a price: The overall proportions are distorted, and the proportion of change as related to the baseline is thrown off by that enlargement.

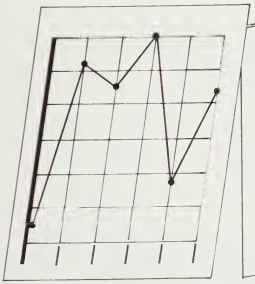


The field can be "broken" or the vertical axis interrupted in order to remove an unused area of the grid. The space thus saved can be used to make the diagram that much smaller, or it can be distributed to the active part of the diagram to increase its scale and thus make its details more visible.

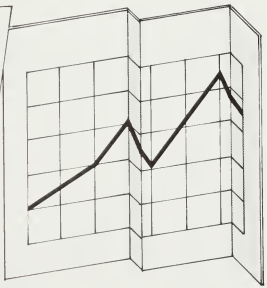
The field is as malleable an element in chartmaking as are all the other more obvious items. The possibilities for variation are nearly infinite, and there is no law that prohibits use of different techniques. Rather, common sense and judgment will determine whether their use is appropriate in the context in which the chart will be seen and for the audience that is to be addressed. The following are examples illustrating the wide range of options at your disposal.



Cunning use of color throws attention onto the crucial area of the chart. Here the difference between the actual (solid line) and projected (dashed line) is left white, and the surroundings are tinted. Were colored ink available, perhaps that area could be filled in with red to make it stand out.



Vertical lines are tilted, drawn at an angle. This yields a dynamic, moving, grating effect.

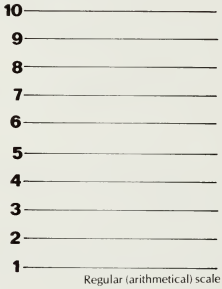


Considering the possibilities inherent in using the field as a pliable plane in space opens up vistas of imaginative chart-making. Here the folds can signify important breakpoints that affect the figures in the sequence.

Logarithmic grids

The conventional chart is based on arithmetical progressions of numbers: 1+1+1+1 and so on. Amounts (in figures) are represented by equivalent sizes or distances on paper. Calculations are done in absolute numbers, the kind we count with. Any increase or decrease is represented by adding or removing units in one direction or the other—by making bars or distances from the horizontal axis taller in direct proportion to the numbers we are working with, and by making the horizontal axis, which usually represents time, correspond to the units of time expended by the subject of the chart.

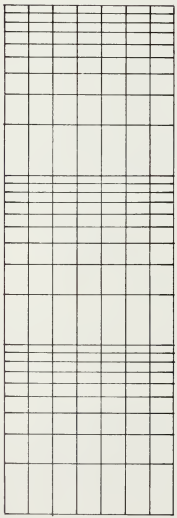
By contrast, the logarithmic graph is based on a different set of numbers and therefore has a different set of purposes and uses. It shows percentage rates of change (or ratios of change) by using a grid whose spacing is based on the logarithms of the numbers being plotted. The reader's first clue that the chart is based on logarithmic progressions is the way the grid looks. The vertical scale is, indeed, peculiar.

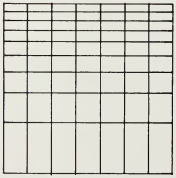


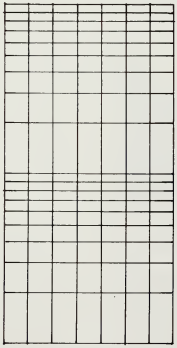
Regular (arithmetical) scale

Logarithmic (log) scale

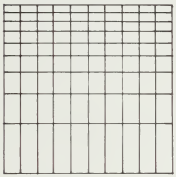
You can stack logarithmic scales atop each other, should you need more than one group of ten (called a "cycle"). Stacking two on top of each other logically results in a "two-cycle grid"; three gives you a "three-cycle grid."


Three-cycle grid

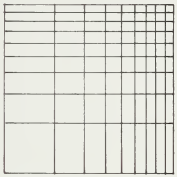

One-cycle grid


Two-cycle grid

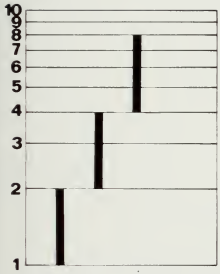
Furthermore, the vertical logarithmic scale can be attached to one of two different horizontal scales. When you combine a vertical log scale with a normal (arithmetical) or regularly segmented horizontal scale, you have a "semilog grid." If you combine a vertical log scale with a horizontal log scale, you end up with a "log-log grid."



Semilog grid



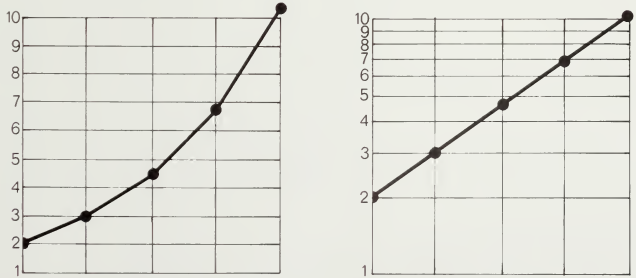
Log-log grid



When you plot data on a logarithmic chart, interesting things begin to happen with distances: The vertical distance representing 100 percent will measure the same length wherever it happens to fall on the chart, in spite of the fact that the horizontal grid lines appear bunched closer and closer together toward the top of the figure. The same holds true of any other percentage increase or decrease measured in the direction of the log scale.

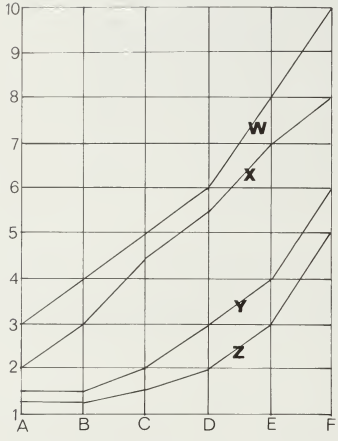
The increase from 1 to 2 is 100 percent. So is the increase from 2 to 4 and the increase from 4 to 8. The bars are all the same length. They represent increases compared to each other, rather than actual arithmetical numbers.

Because of this fact, a percentage increase sequence plotted on a logarithmic grid comes out as a straight line, whereas on a plain arithmetical grid, it would look like a curve.

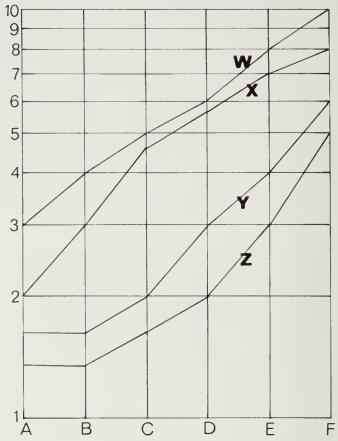


The same increase plotted two ways. On the arithmetical grid it is a curve; on the logarithmic grid it looks like a straight line.

This becomes useful when you are faced with comparing rates of growth, whether increase or decrease. In an arithmetical chart, the figures are shown in absolute numbers, and the viewer can quickly read off their totals at any point.



Data plotted on a normal arithmetical grid.



The same data plotted on semilog grid.

However, when rates of change are more important than absolute numbers, it is difficult not to have one's judgment swayed by the totals. In the arithmetical version of the data shown above, the top of line *W* is so much higher at 10 than it is at its start (3) that one is led to believe that line *W* is the most "successful" of the four shown on the chart. Yet it is not the most successful by any means. Rather, line *Z* is far more successful in terms of rate of increase (from 0.25 to 5). True, it is possible to discern this dramatic increase by dint of careful scrutiny, but it is hidden under so many other lines and so near the foot of the chart that it is not immediately noticeable.

The same facts plotted on the semilog scale prove that the improvement in line *W* is modest compared to that of line *Z*. Thus, if your purpose is to demonstrate relative rates of change, the logarithmic charts will suit your ends better and more dramatically.

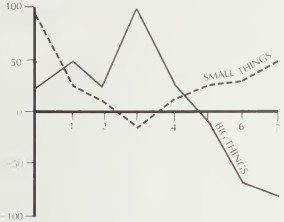
Constructing a log grid is a difficult process, but ready-made grids in a variety of configurations are readily available at any art supply or drafting-materials store. Even office supply outlets stock them. The forms are usually printed in light green or light blue color that is not intended to register in reproduction ("non-repro blue"). It will therefore be necessary to ink in the grid lines you wish to be visible when the chart is printed.

Percentage comparison charts

This special format of curve charts can be used when you need to compare values that have been converted to percentages. Far simpler than logarithmic charts, which are better suited to showing percentage rates of change, these show the percentage data without stressing rate of change. They are ideal for comparing actual relationships of various lines to a baseline, or "index."

The horizontal (*X*) axis is broken into segments in normal, arithmetical progression—hours, days, years, and the like. The vertical (*Y*) axis is broken into 100 percentage points: Upward from zero is positive; downward is negative.

Since all data to be plotted are converted to percentages, the plotting is elementary. (The boring part is figuring all those percentages before starting out on the graphics!) The advantage of a percentage comparison chart form is its capacity for comparing widely disparate subjects—huge versus tiny, dollars versus cruzeiros, tractor versus intimate apparel production.



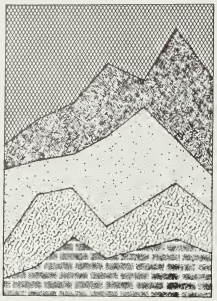
Since the figures of both lines are converted to percentages, it is possible to compare subjects that might otherwise be hard to compare.

Compound surface charts

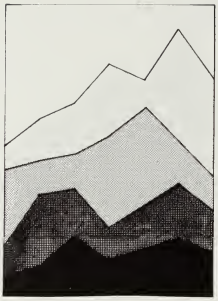
Where several curves occur on the same diagram and do not overlap, they may be rendered as curves or as surfaces. Assuming that the specifics of the situation warrant the use of surface chart presentation, you should know the techniques involved in rendering surfaces. The concern here is primarily aesthetic, because it has little effect on the substance of the diagram. The way a product looks, however, is an integral part of its success, or failure, at communicating content.

The problem is how best to distinguish one area from another as areas without rendering the actual lines. In order to allow the edges of the areas to stand out sharply against each other, it is necessary to give each area its own color or texture. This can be done by using a number of various shading mediums. Obviously, if color is available, you should use it for the richness and decorative effects it offers. When no color is available (which is true in the great majority of cases), you have two options: Either make each area as different from its neighbors as possible with a random arrangement of tints and textures or integrate them into coherent relationships by the way each area is rendered.

These tints, available in sheet form in 10 percent increments of darkness and lightness, can be affixed to artwork to yield the same result a printer would produce by stripping in specified tints. (That process used to be called "Benday" in the days of letterpress printing, and the term is still often used to describe the negative film the printer provides for offset printing.)



A wide variety of tints and textures is used to distinguish one area from another. They can be cut out from prewaxed transparent sheets and adhered to the artwork or transferred to the artwork from rub-off sheets. Equivalent results can be achieved in electronically produced charts.

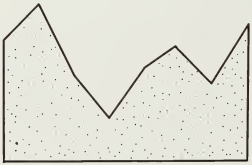


Coordinated tints step up from darkest to lightest. They evoke an image of mountains receding into the distance, the darkest being closest and the most distant the palest; the sky is the lightest of all.

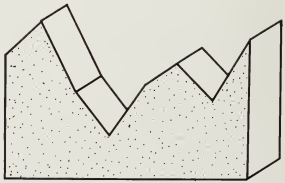
Coordinated tints step down from darkest to lightest. Here they evoke the image of a night scene, with a black sky, and the most brilliantly lit area closest to the viewer.

Surface charts in three dimensions

Creating an illusion of dimension (depth) by attaching a surface to a wall (and perhaps by cutting it out in jigsaw-puzzle fashion) makes a chart visually interesting. It also makes the task of studying data fascinating and enjoyable. For example, here is a typical surface chart:

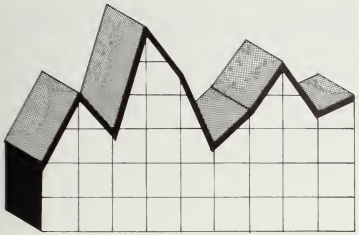


and here is the same form given a third dimension:

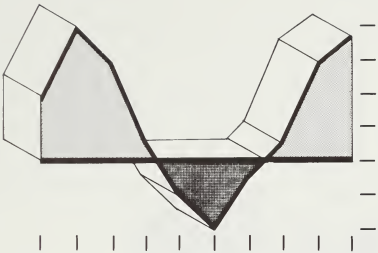


The drafting skills required to render these diagrams are exactly the same as those described in Chapter 3, on bar and column charts. Yet the difference in visual impact this simple technique yields is literally beyond words.

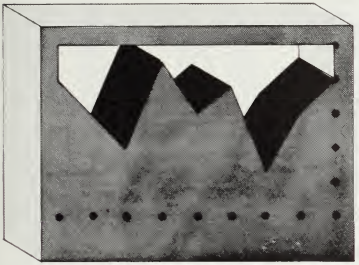
To give you an idea of how versatile this chart form is, here are a number of variations on the basic theme.



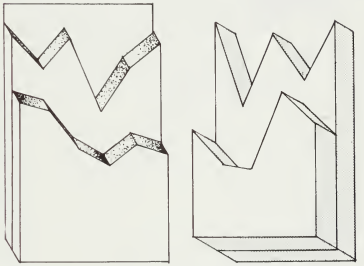
The "mountains" are outlined in bold, while the grid is lightly drawn over the surface. The closeness of the grid to the curve allows for precise numerical extrapolation.



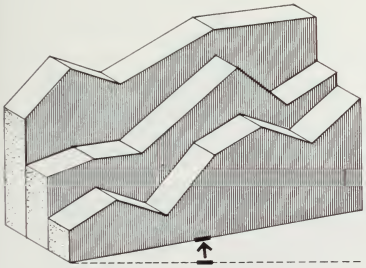
The "mountains" are again outlined in bold, but the surface is colored in darkly to emphasize the negative area. Here the indices are somewhat less useful because they are far from the action, but the overall shape gives a striking impression of ups and downs.



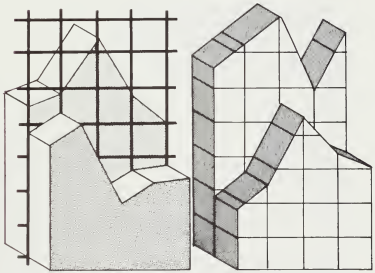
In this unexpected treatment the grid is a three-dimensional block and the mountains appear to have been carved out of it. The tinting of the surface and the darkness of the edges call attention to the outline of the "hole."



Two layers of surfaces have been placed next to each other in both these diagrams. They can be viewed from above (left) and below (right).

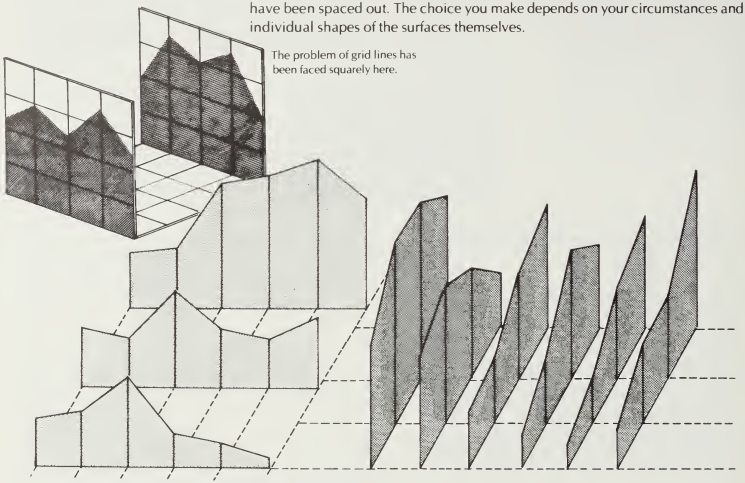


Three butting layers create a complex image. Lifting the horizontal axis up at a slight angle creates a more naturalistic impression and thus helps the viewer accept the diagram; that, in turn, makes it more likely to be studied.



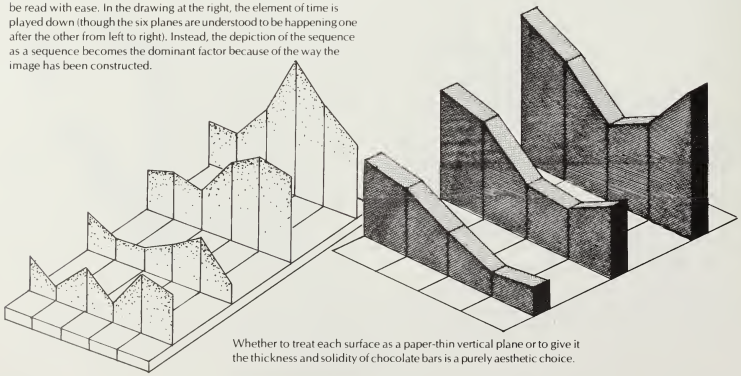
Two sets of twin planes illustrate the problem of what to do with grids in such complex situations. The diagram at the left places the grid between the two planes, so the reader can use it to measure both equally accurately. The diagram at the right shows the grid drawn over the entire surface, with the lines continued "around the corner" onto the curved plane.

In compacted solids, overlapping shapes might hide crucial information; therefore separated planes would be a good alternative, for nothing can be hidden there. In the following multiplanar comparisons, the surfaces are separated from each other and arrayed in receding fashion. The third dimension is utilized in a slightly different way. Instead of making slabs with weight and thickness, the surface charts are kept thin and have been spaced out. The choice you make depends on your circumstances and the individual shapes of the surfaces themselves.



The problem of grid lines has been faced squarely here.

In both these renderings, the time sequence on the horizontal axis is clearly legible, reading from left to right, as expected. In the drawing at the left, the progression in time, as manifested in the three surfaces, can be read with ease. In the drawing at the right, the element of time is played down (though the six planes are understood to be happening one after the other from left to right). Instead, the depiction of the sequence as a sequence becomes the dominant factor because of the way the image has been constructed.



Whether to treat each surface as a paper-thin vertical plane or to give it the thickness and solidity of chocolate bars is a purely aesthetic choice.

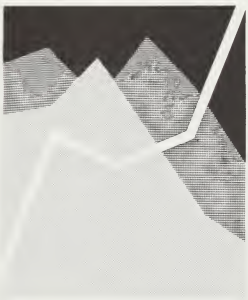
Curve and surface charts combined

Curves stress rates of change; surfaces stress amounts of change. There is no reason why the two graphic techniques should not be blended together, if the story to be communicated warrants it. Such a combination is called for in situations where you need to compare one development (one curve) against one or more others. There has to be one dominant element; the others must be secondary, supportive. That way you can render the important element as foreground and the others as informative background. To illustrate the principle, here are four versions of the same set of data presented in four different ways.

The raw data plotted and shown in plain line curves. None appears more important than the others, and no opinion is indicated.

The same data shown in varied line weights to distinguish the relative importance of the lines.

Using the same data, the important line is rendered as a curve and is superimposed over the two other curves that have been made into surfaces.



A variation of the same technique reverses the darks and lights and drops out the important curve from a dark background.

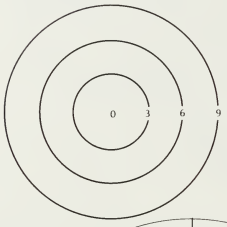
Circular charts

Progression of time is easy to show in a line that flows from left to right. Everyone understands the principle, especially if the horizontal line is clearly labeled.

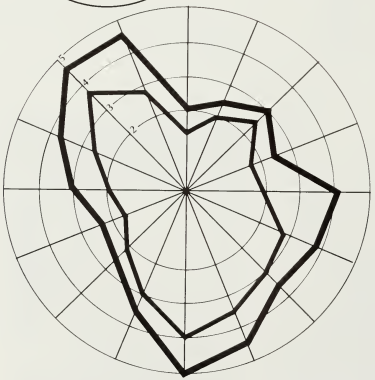
A problem arises when you have to show cyclical or repetitive data. Things happen over and over again without a clear start or end—the seasons flow into each other, tides ebb and flow, phases of the moon repeat endlessly. Often it would distort the image to break such a cycle arbitrarily at any one point. After all, the weather doesn't "end" on December 31 or "start" on January 1; it merges imperceptibly from one day to the next throughout the year. If such overlapping or smoothness of flow is important, then a circular graph is called for.

Undoubtedly, the circular shape is harder to read than a unidirectional one, but it does have its logic, and used cunningly, it carries great impact. It may require careful study, but its shape invites such study.

The center is zero. You can plot the increases in value by radiating outward at regular intervals—the further a point is from the center, the higher its value. Starting at 12 o'clock, you impose time sequence in a clockwise fashion, dividing the circle into as many segments as are needed. Use a regular 360° protractor to divide it into units of threes (6, 12, etc.) or the decimal protractor for tens.

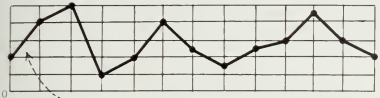


The center of the circle is equivalent to 0. Values increase as the distance from the center increases.

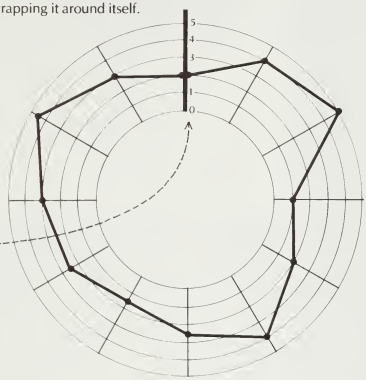


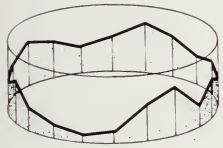
Two versions of typical circular charts, drawn as curve and surface diagrams. There is no doubt but that these amoeba shapes are unexpected images. An alternate plotting method using columns arrayed in a circle can be seen on page 52. The same criteria for choice obtain: rate of change (plain curve), amount of change with rate as secondary requirement (surface), amount of change at specific intervals (columns).

Making the center (0) a single point may be somewhat restricting, but it is possible, and simple, to expand that central point into a full circle. You do that by elongating the single curve chart and wrapping it around itself.



The straight-line chart curled around to bring the two ends together. The 0 is shown on the crossing of the two axes, as usual.

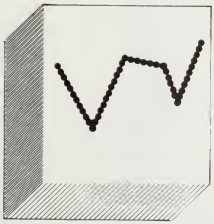


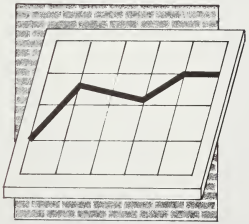


What happens if you take this circle and stand it up sideways? The result is a circular chart of quite a different sort. To make such a diagram might be difficult, but it is well worth the effort. It would perhaps be easiest to draw it on a strip of acetate, twist it into a circle, and then make a photo of it. You can then print the photo or use it to trace the diagram; either way would be quicker than trying to set up correct figures on oval-shaped coordinate lines.

Frames and boxes

The background against which charts, any charts, are seen is an area where imagination can be applied at will to arouse interest; for no harm can be done to the statistics in any way. In itself, the background has no significance, so you can manipulate it however you want. Here are two examples to make the point. (For more on frames and boxes, see Chapter 9.)





Without the shadows and framing, both these charts would be comparatively uninteresting. But to engrave the line (made of dots) on the face of a silver ingot with knurling on the edges, or to make the zigzag graph the front of a slab floating in front of a wall, gives you results well worth looking at.

■ These are a family of function and process diagrams whose branches spread in all directions. They run the gamut from static descriptions of relationships of people within an organization to diagrams of events over periods of time in history. They can describe complex manufacturing flows where materials enter the stream and then leave, results change, and the cycle begins again. Because they can be analytical, flowcharts thus serve the purposes of management in planning and forecasting. There are an infinite number of hybrids, which makes it difficult indeed to split them into logical groupings. For our purposes six groups have been selected, all dealing in some way with the same aspect of this presentation format. Each is introduced by a short description outlining the aptness of that particular form for a specific communication purpose. They are the following.

1. *Schematic diagrams,* which show relationships between theoretical concepts.
2. *Organization charts,* which depict static human relationships.
3. *Verbal step-by-step diagrams,* which describe stages of a sequence.
4. *Process charts,* which elucidate complex stages and relationships.
5. *Time lines,* which illustrate simple time sequences.
6. *Time-and-activity charts,* which combine time lines with process charts.

Schematic diagrams

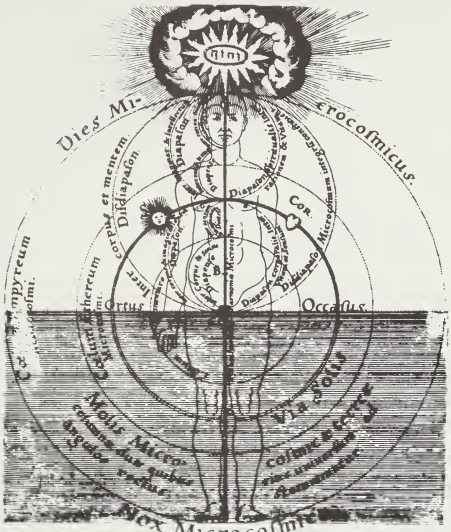
If you think of an organization as a group of related functions or interactions, you have a clue to the use of schematic diagrams. The functions can be existing or intended; they can be precise or vague—but all can be described graphically because diagrams such as these are understood to depict principles rather than facts. The tighter and more factual the principles are, the greater the credibility of the diagram will be, of course.

Schematic diagrams have nothing to do with personnel in any hierarchical sense, or even with large-scale departmental divisions; those are secondary considerations (i.e., who will carry out the mission). Rather, these diagrams describe the needs and functions to be fulfilled by people at a later stage. Schematic diagrams are essentially planning aids that provide management with analytical overviews on which to base decisions. However, they can also be used as sales aids because they are clear tools of persuasion. They can be so impressive with insight that their blandishments become irresistible.

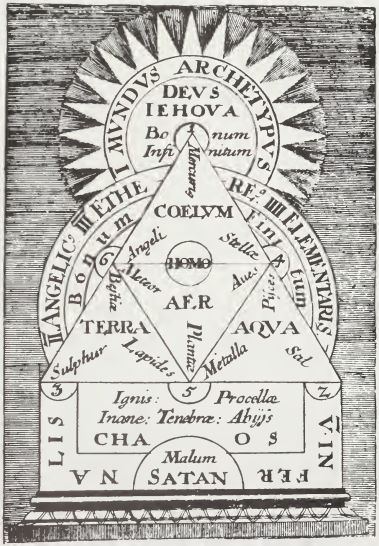
Schematic diagrams are nothing new; they have been used to promote ideas ever since the skill of transforming abstract thought into diagrammatic illustration was invented. Here are a couple of examples that show more than a little ambition on the part of their makers, for each attempts to explain no less than everything in one diagram.

There is a serious purpose in showing these masterpieces of the diagram maker's art besides the simple pleasure of seeing them, or even the pride we may well take in following in their makers' footsteps. That purpose is to stress the fact that nothing is too obscure or too complex to turn into visual form. On the contrary, the transmogrification of verbal ideas into visual images helps to define and clarify ideas and gives them a shape that communicates them to others more clearly and certainly much faster than verbal description could hope to do.

Clearly, each individual situation dictates its appropriate solution in a diagram

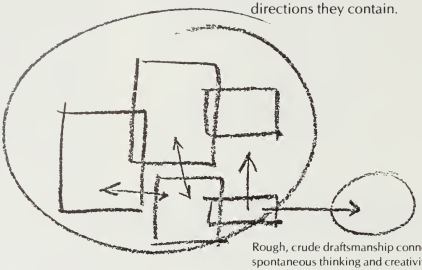


This diagram dates from 1617 and comes from a book by Robert Fludd, *Utriusque Cosmi Historia*, published in Oppenheim, a German town. It shows man as microcosm of the universe, with a variety of philosophical concepts related to the various parts of the body. Thoughts, for instance, reside in the head, which reaches to the heavens where God is to be found; the upper torso is connected with the day, while night and other unwholesome aspects of existence are situated in the nether extremities. This is consistent with the principle that goodness, importance, and excellence are at the top of a diagram, and their opposites are placed at the bottom — as in organization diagrams.

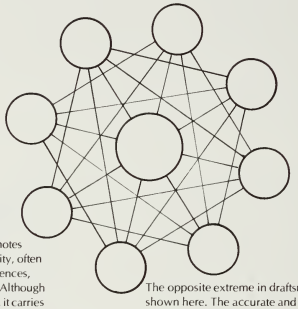


This is a picture of the Hermetic scheme of the universe; it comes from Thomas Norton's *Musaeum Hermeticum* published in Frankfurt in 1749. It organizes Creation — all of it — with God and Infinite Goodness in the top circle and Heaven with stars and angels in the top triangle (Mercury, as both the messenger of the gods as well as the metal, appears in the triangle's apex). The inverted triangle beneath contains air, birds, meteors, and plants. In the circle suspended precariously between them floats man. The triangle at left concerns earth, stones, beasts, and sulfur; the one at right contains water, fish, metals, and salt. Under them are fire, shades, the dead, and chaos. They are surrounded by the infernal where Satan is ensconced in the company of evil. This should persuade you of the capacity of diagrams to crystallize the makeup of the universe.

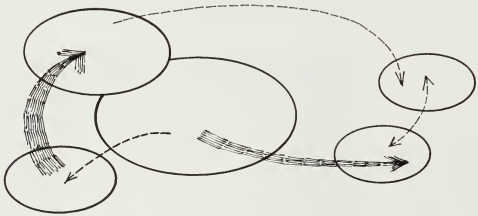
custom-fitted to its specific meaning and requirements. This is another way of saying that you are on your own when starting out to chart complex ideas in this way. There are, however, a few commonalities to this form that are worth studying for the possible directions they contain.



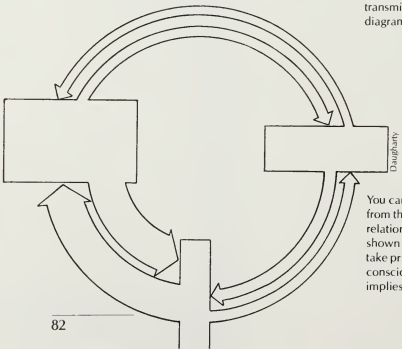
Rough, crude draftsmanship connotes spontaneous thinking and creativity, often the result of brainstorming conferences, lunch discussions, or chalk talks. Although such a drawing is easy to produce, it carries great impact because it has that feeling of immediacy as well as an afterimage of its creator. This kind of drawing is nicknamed a "bubble diagram" because of the shapes it uses.



The opposite extreme in draftsmanship is shown here. The accurate and formalized geometrical style connotes the opposite of spontaneity, implying careful study, development, and final crystallization in a figure that is obviously meant to express permanent truths.

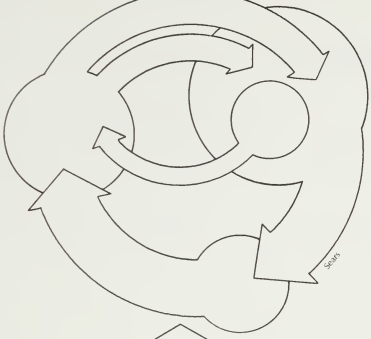


There are many ways to diagram strategic thinking. Here the various components of the problem, shown as ovals (which could be viewed as circles in perspective), are given sizes commensurate with their importance. Two of them overlap, thus denoting such an intimate relationship that no arrow is needed to join them. Arrows of various widths and blacknesses express degrees of influence: Wide arrows are clearly interpreted as determinant or important ones, whereas dashed, light arrows are seen as subsidiary, advisory influences. The bare-bones style of draftsmanship shown here is adequate to transmit the basic ideas inherent in the diagram.

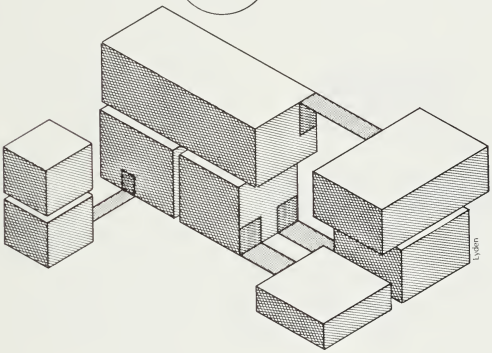


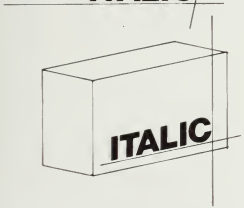
You can graphically shift the emphasis from the elements to their connecting relationships. The three boxes are indeed shown in different sizes, but the arrows take pride of place in the viewer's consciousness. Their varied thickness implies their relative importance.

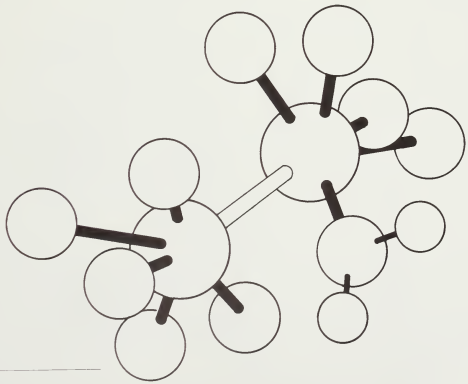
This variation of the preceding example illustrates the visual delights that diagrams are capable of, while at the same time transmitting useful information. As above, the arrows' widths are symbolic of comparative importance, as are the sizes of the circular "boxes." Circular shapes allow overlapping and superimposition of elements to be more credible, for they look less geometric (i.e., artificial) and more organic (i.e., natural).



By stacking three-dimensional blocks you can make groupings more clearly visible. Labeling the elements may be a disadvantage of this sort of rendering because it is difficult to get the lettering to "sit" properly on the sides or tops of the various boxes unless you use rub-off sheets specially made for the purpose. If there is a great deal of such lettering to incorporate, a useful trick might be to draw the boxes not on the usual 30°/60° angle, but to use the angle of the italic typeface you have chosen. Your labels, attached at a similar angle, will then be absolutely correct in appearance.







Here is another format for presenting static combinations of data in diagrammatic form. Somewhat reminiscent of models of chemicals, it is hard to draw but very easy to make as a model. Using Ping-Pong balls and dowels, you can assemble them, paint them, letter them, and then photograph the finished construction.

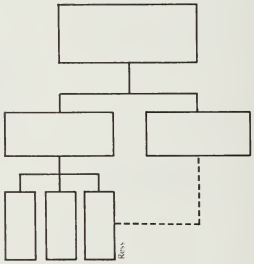
Organization charts

These are nothing more than the visual representation of a static condition. That is, they depict relationships of entities to each other in terms of comparative authority or responsibility. Direction within these diagrams is universally accepted as flowing from top to bottom; the top represents the area of greatest importance, the bottom that of lowest status.

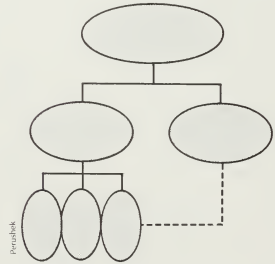
The visual purpose of this type of diagram is to clarify the hierarchical rankings within an organization. Since no charts can ever be encyclopedic and show everything, the subject needs to be carefully edited down to its barest essentials. Only then will the true meaning of the diagram come across vividly.

Such simplification does not mean that the diagram needs to look boring, however. The comparative weight of the lines that connect the units, the comparative size of each of the units, and the comparative boldness of the type used in setting the words inside the boxes can all help to emphasize those areas deemed worthy of such treatment.

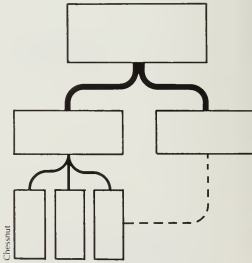
The variety of graphic handling of which an elementary organization chart is capable is astounding. Only a few examples are shown here, but you can imagine the further variety that is possible when you add type to the diagrams, which are, after all, only background to the words.



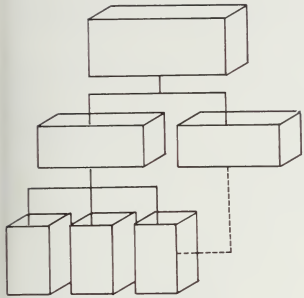
The basic organization chart is a statement of facts. Here you see, obviously, the boss in the box at the top; below that are two subordinates of equal rank. Three "underlings" report to the subordinate at left; the subordinate at right has no staff, but serves in an advisory capacity to one of the associate's staff. Such a partial relationship is indicated by a dashed line; a solid line implies full and direct responsibility upward, control downward.



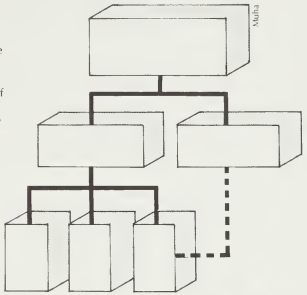
Although the information here is identical to the charted data above, the effect is quite different in this version. The linking lines are played down, while the boxes are emphasized.

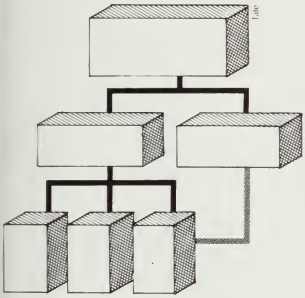


This variation of the same diagram emphasizes the linking lines of authority at the expense of the boxes.



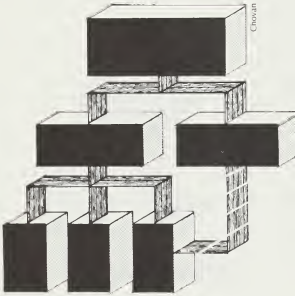
The same boxes from our original chart are here rendered in three dimensions using a 30° angle. To make the three-dimensional illusion work and to avoid overlapping the boxes, these have simply been spread a little farther apart. Doing so affects the placement of the connecting lines: Some of them fit neatly balanced, others don't. But lack of precision in axial balance is hardly noticeable if the drama of the diagram camouflages its shortcomings. The draftsmanship is identical to that in the first diagram of this series; only "sides" have been added to the boxes, to help make them the dominant element.

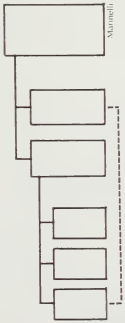




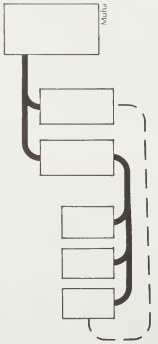
These boxes are identical to those in the previous example, except the rendering is more naturalistic because it uses two tones of screens rather than one in the shading. However, because the connecting lines are much bolder and have been placed at the "back" of the boxes, they appear to be the dominant feature of the diagram.

Here the fronts of the boxes have been blackened (in preparation for inserting white type) and the connecting lines have been dimensionalized to look like paper-thin walls. The result is a visually arresting image that says nothing more than the first rendition of this series, but that does so more ostentatiously.

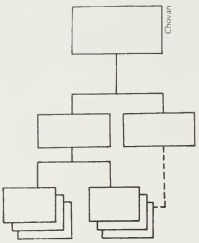




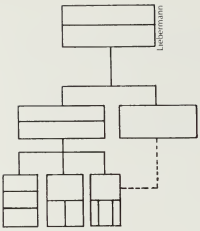
Organization charts can be composed to fit vertical space. The facts may be exactly the same as those shown in a horizontal configuration (such as the preceding ones), but the interpretation at first glance may be somewhat different. Since the vertical diagram stacks elements atop each other, the implication of hierarchy cannot be escaped. In a horizontal arrangement, equal-ranking functions are presented on the same level. However, you may have to opt for vertical display to save space or to fulfill the purpose of planned exaggeration.



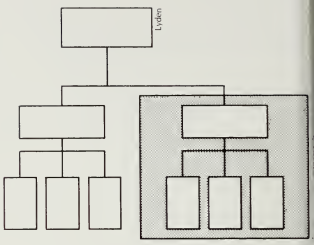
This is identical to the preceding diagram, except that the lines appear to be crucial because they are much bolder and have rounded corners. The line that appears to transect box X affects the viewer's interpretation of the chart by drawing attention to that particular unit.



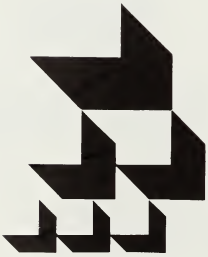
A quick and simple — and space-saving — device such as the one shown here can be used to assemble and show a number of like-sized elements of equal rank, all of which are easily countable, too.



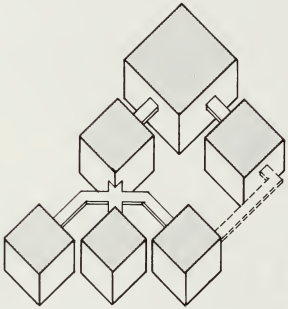
This more complex diagram shows a double set of organization levels: intra-departmental (within each box) and inter-departmental (between the boxes).



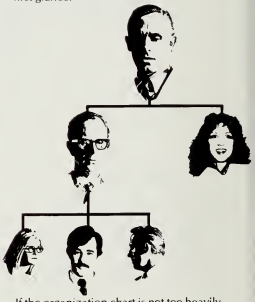
The block of tint that encompasses the boxes at right identifies a separate wing of the organization. A similar effect can be achieved by running a line around the area instead of tinting it, although the purpose of such a line is likely to be less clear at first glance.



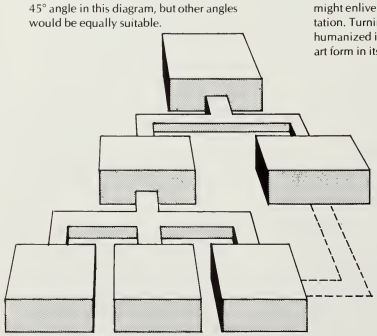
No actual boxes are drawn here at all — the shadows that they would cast define their edges in our imagination. The boxes have to butt, in order to help the viewer visualize them; that, in turn, means that the lines of responsibility between boxes as well as ranking have to be inferred purely by relative position. Admittedly, such graphic trickery limits the use of the chart form, but it is certainly worth considering, if only for the sake of visual amusement.



The same facts presented on the previous pages are seen here as solid blocks viewed from the air. The construction is based on a 45° angle in this diagram, but other angles would be equally suitable.



If the organization chart is not too heavily populated, substituting mug shots for names and possibly even for the functions might enliven and personalize the presentation. Turning theoretical diagrams into humanized illustrations such as this is an art form in itself.



A one-point perspective may well be the ideal means of turning a lackluster set of facts that would normally be presented in some clichéd fashion into an exciting blockbuster of a diagram. There is no question but that it is a complicated drawing to construct and this restricts its use to situations where such investment of effort is likely to be appreciated. (For more on perspectives, see page 48.)

Verbal step-by-step diagrams

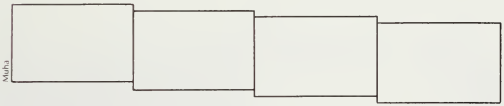
How often have you needed to describe a long sequence of steps in which one thing leads to another, cause yields effect, and so on? Given the "if/then" nature of such sequences and the vast potential for convoluted courses of alternatives, it is quite possible that the reader will grow weary, become confused, and stop paying attention.

Giving such material a visual representation not only helps to organize the information but it helps to keep your readers interested, for they then become *lookers* as well. It is an accepted fact that we gather and retain information through the eyes more effectively than any other way. Obviously, reading is itself a visual activity, but it can be enhanced by breaking up the monotonous text into its logical subcomponents and then diagramming them. Your chances of getting through will be much greater if the form can be made to reflect its contents.

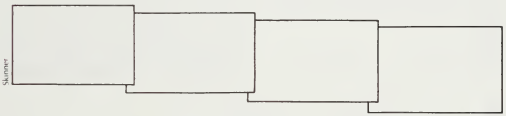
Sequencing a series of statements in boxes across the page from left to right makes a diagram perfectly straightforward and comprehensible, especially if each box is numbered. Placing them vertically or diagonally down the page works just as well.

If the space is not wide enough to accommodate the full horizontal sweep of boxes, then you need to break the sequence somehow. One key to success is to vary the spacing. Here the contiguous (horizontal) units have been joined with narrow bands of space, and the two separate rows are distinguished from each other by a wider band of space. By so organizing the units, you allow the reader to avoid reading in the wrong direction, which equal spacing makes inevitable. Staggering the rows is an added inducement to follow the sequence correctly.

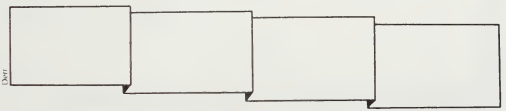
Butting the boxes at their vertical edges and staggering them down the page shows the reader an extremely obvious direction in which to follow the sequence of stepped thoughts.

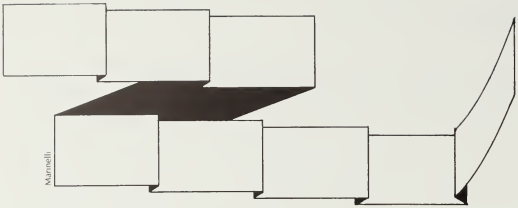


Overlapping the ends of the boxes creates the illusion of an overlapping set of cards.



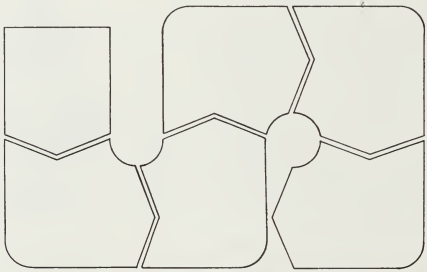
Here the little square of overlap seen in the previous version has been divided diagonally and the triangle inked in. It now looks like a folded strip of paper.



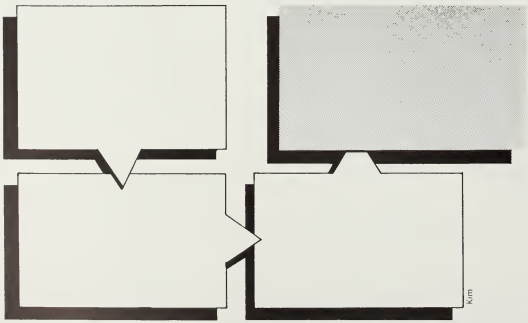


Taking the paper-folding technique a step farther, the paper strips can be folded back on each other.

The rectangular shapes can be varied simply by changing the angle of the vertical edges. Here an arrow form gives the image a dynamic, moving character.

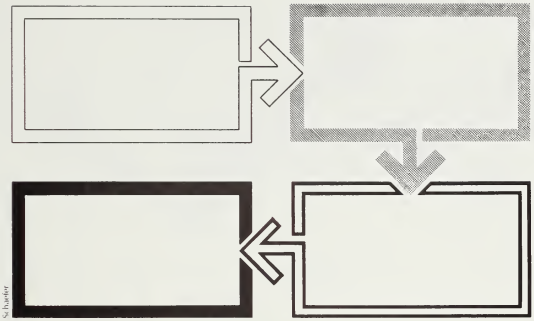


Any shape that contains its own direction (such as an arrow) allows for convolutions. The continuous arrow shown here may be a response to the need to concentrate information into a constricted area, or it may be needed to explain the relationship between segment 3 and segment 6. Whichever it is, such snakelike meandering can make information look intriguing, especially if the shapes are colored some way (whether in a multitude of hues or in plain gray) so that their sinuousness becomes an important visual factor. When repetition or iteration needs to be emphasized, arrows can chase each other around in various configurations. (See Chapter 10, arrows 110, 126, 128.)



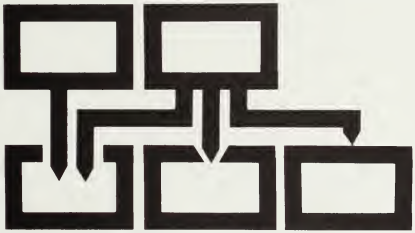
The arrows are shown here as tabs attached to cards that appear to be floating above the surface of the paper (because of the shadows they cast). The final unit is tinted to differentiate it from the preceding ones, which can be interpreted as building up to this desired goal. The arrow tab that appears to be going underneath the surface of the final unit is likely to be interpreted by the viewer as a signal relegating the information on all the preceding cards to subsidiary or background status.

The boxes are defined by frames that turn into arrows. They are rendered here using four different techniques to show what can be done to change "color" or tonal gradations even in the simplest of situations.

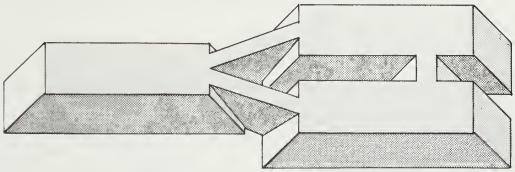


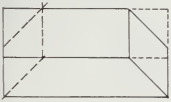
S. Duotier

The outlines of these boxes, as well as the arrows that join them, have been drawn to the same width. (Obviously, the lines are much too fat for the space the diagram occupies, but they've been exaggerated to make the detailing clearer.) Notice the regularity of spacing between the arrows. Such workmanship helps to give an aura of precision that, in turn, makes the statistics so presented more credible. The crisper and cleaner and the more carefully presented the diagram is as a whole, the more valuable does the viewer deem the facts to be. Notice, also, the three different ways of handling arrowheads: Two are shown penetrating deeply into one box, another just punctures the skin, while the third barely caresses it.

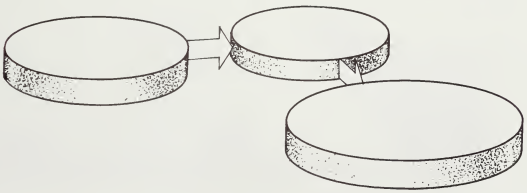


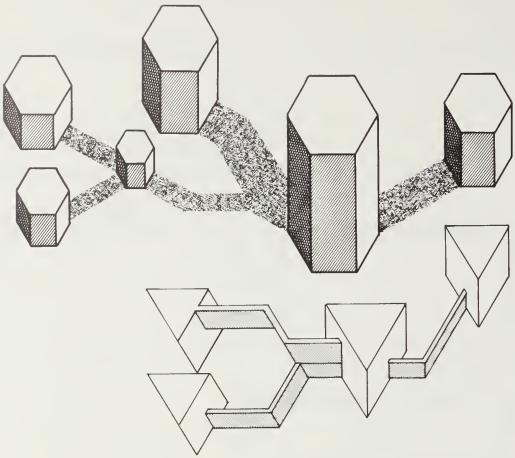
This is an exercise in making simple objects look complicated. It is a three-dimensionalized rendering of three boxes with the ends lopped off at 45°. The value of such complexity is its intended effect on an audience that might be swayed to pay closer attention to the message if the medium is ostentatious.





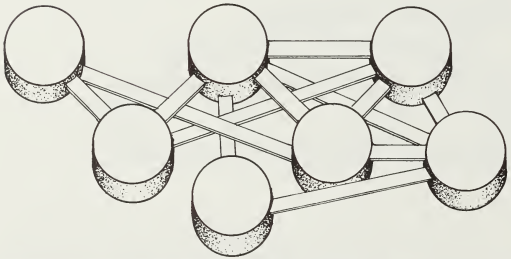
Another variation on the theme of graphic embroidery would be to make the "boxes" pill-shaped. After all, why must a box that contains a sentence or two be rectangular? There are no rules of behavior, no rights or wrongs in chartmaking. There is only one valid criterion: fitness to purpose.





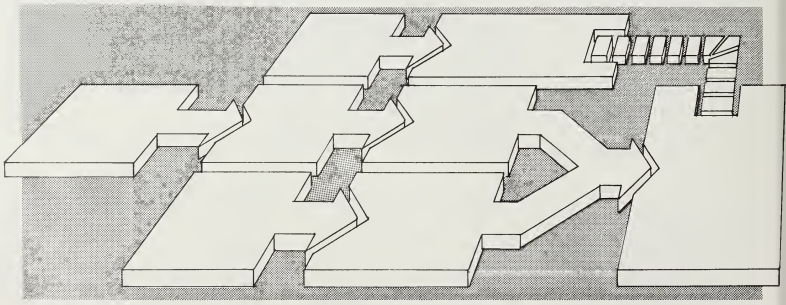
Size is another dimension to be considered and manipulated. The oval shapes in the preceding example do indeed vary in size, but they look so right, lying there like pancakes on a griddle and getting smaller as they recede in the distance, that their different sizes become part of the aesthetics rather than the content (statistics). Here, however, the sizes are unequivocally significant to the interpretation: Each "tower" has the same shape but is of different size, and the "pathways" that connect them vary in width. The viewer is bound to interpret this size variation as symbolic of the relative importance of the objects as well as the links between them.

This represents a variant on the preceding example, using triangles instead of hexagons. The lines connecting the triangles have been rendered as "walls" of varying heights.



The usefulness of the third dimension is clearly illustrated in this rather complicated image. That complexity is precisely the point: Interwoven elements such as the ones shown here are joined with "bridges" crisscrossing at various levels.

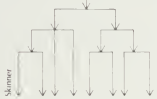
Boxes with arrows are rendered here in perspective against a dark background. The context and purpose of the diagram together with common sense, must determine your choice of presentation technique.



Process charts

All too often the complexity of relationships bedevils understanding, if verbal description is all that we have to depend on. Process charts (or *flow diagrams*, as they are commonly called) give us another means of communicating. By showing—rather than telling—what happens in a process, they help us to reach a clearer understanding faster.

A relationship such as the following diagram depicts would take paragraphs of prose to describe, yet this sequence showing disintegration at unequal rate explains the process succinctly in a space 1½ inches square.

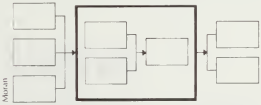


Skinner

Here is the opposite process—an unsteady conglomeration into a unified result—shown in the same size space.

Marinelli

One more example of complexity made simple—a picture of concentration leading to a subgroup within a flow that leads, in turn, to dismemberment in three stages.



Moran

Not only do these diagrams describe relationships but they also use graphics to inform the viewer of the direction of the flow. The first diagram, above, does it with arrows at every node; the second one implies it with angled lines; the third uses arrowheads at selected critical points. Here are more graphic techniques from the wide variety available.

Zelbeck

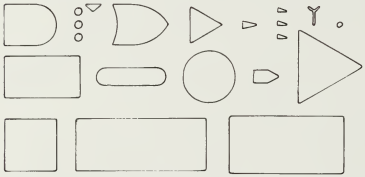
Pulsations are illustrated by rhythmic change in tone values within the "tube," in which arrowheads have been indicated with 30° angle tips.

Zelbeck

Signals reminiscent of traffic markings on roadways consist of chevron shapes alternating between solid black and empty white.

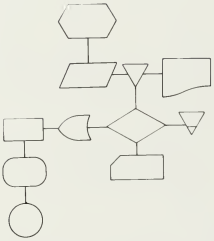
A stream representing totality comes in from the left and slowly subdivides into fingers of varying widths, each clearly representative of the importance of that particular component. It is a picture of staged, controlled, sequential disintegration over a period of time.

The variety of graphic means at the chartmaker's disposal can lead to originality of expression as well as clarity in transmitting ideas, if the right means are used for the specific requirements. There is, however, another side to this entire communication process. That is the need for standardization in graphic symbols used for diagrams whose dissemination is likely to be extremely wide, technical, and governmental. In such work, the happy freedom enjoyed by individual chartmakers is severely restricted. Here are some of the most common symbols used in logic diagrams.

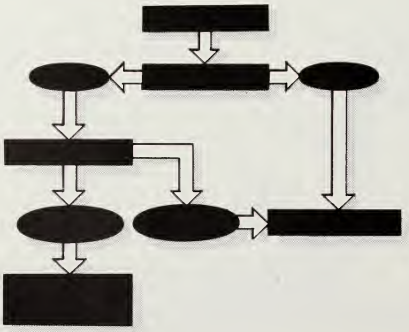


All such symbols have standardized shapes and sizes that must be used to produce the correct results. Templates are available for ease of drafting.

Given the understanding of the tools available, here are some examples of process charts to illustrate some of the variety of mood and expression of which the genre is capable.

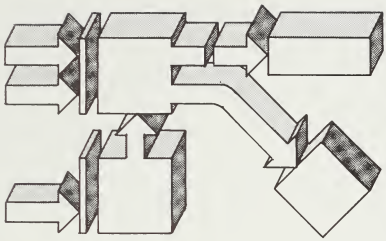


This is a typical diagram based on standard logic symbols. Its graphics are not particularly soul-stirring or dynamic, but they do communicate the facts efficiently and succinctly.



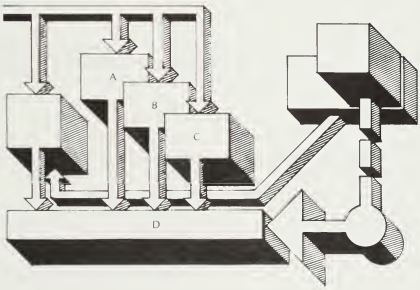
If the shapes used are simple geometric ones, their very simplicity offers an opportunity for graphic embellishment. Here the elements of the diagram appear to cast a light shadow on the paper. If, on the other hand, the shapes are complex in themselves (as the little diagram above), then it is wise to let them speak for themselves, without additional decoration. Elegance and simplicity go hand in hand with facile communication.

These simple shapes have been three-dimensionalized and are viewed from above while being illuminated from below left. The boxes are not particularly prepossessing in themselves; the arrows, however, are. The success of the graphics depends on the proportions as well as the "depth" of each shape. Both need to be geared to the size of the front face of the boxes as well as to the need for overlapping. It is in the overlaps that unexpected visual effects are produced.

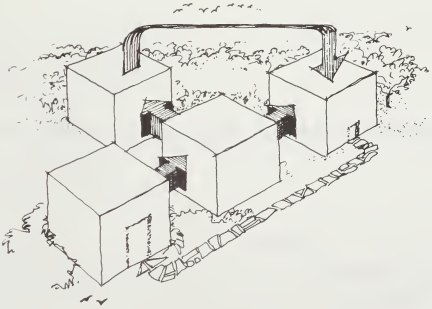


This is another example of three-dimensionalization, but this time the diagram is viewed from below and lit from above. (That, incidentally, is the most natural lighting; we expect light to originate from the sky. Under normal circumstances, the sky is the palest area in our vision; however, if we deliberately reverse the sequence of dark to light and illuminate objects from below, we create surprising drama.)

Another area for variation is the arrows. They don't have to be the depth of the boxes. If you make them shallower, you can use the box as a deep space within which the arrows move at various levels. They can thus weave in and out to describe the inner workings of the diagram. Two examples are shown here. One is realistic (the one that weaves sideways) and the other is based on illusion (the three arrows coming down into the boxes at the top). Those three overlapping boxes (A, B, C) appear to be receding in space, yet the arrows that touch them are evidently at the forward plane, for they all spring from the one horizontal line across the top, or point to the box (D) across the bottom.



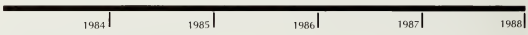
You can carry three-dimensionalization to the logical extreme by setting up your diagram as though it were a picture of objects in space seen in perspective. Not only does that encourage the addition of naturalistic details, such as trees, mountains, and birds, but it also allows you to run the joining lines at any level and choose any shape you like. The diagram itself is based on a surreal inconsistency anyway, and that makes it possible to present any form of graphics — which would be suspect or questioned in more formal diagram presentation — with impunity.



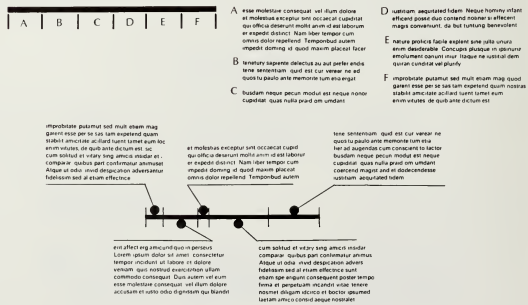
A ←This is where this sentence starts, and here's where it ends: Ω

The start is at the left, and the end at the right. This left-to-right ⟶ motion is so ingrained in us by education and habit that we assume it to be a law of nature that things travel from left to right. (Sequences are also sometimes understood to flow from top to bottom, although this is a rarer form of presentation than the flow from left to right.) Research has also shown that people skim magazine pages from the top-left corner downward in a diagonal toward the lower-right.

We automatically plot time lines from left to right because it seems the most natural way of doing it. And because this is the most common, it is also the most communicative technique. Since the principle is obvious, you begin making a time line by calculating a scale that will accommodate the number of intervals you need to show within the space at your disposal.

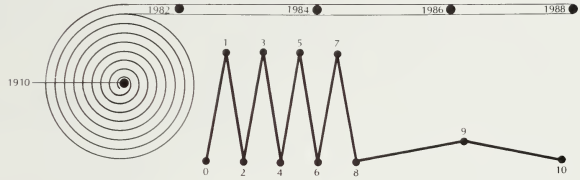


If space is restricted, you can indeed double back in the same fashion that successive lines of text do on a page. But the purpose of a diagram is to allow the graphic arrangement to add its special capacity to explain the data being plotted. So, if you are constructing a time line whose purpose is to compare distances along it to each other, any kind of arbitrary folding or breaking will automatically undo such benefits. No more comparisons will be possible or, if they are still possible, they won't make the point as clearly as they should. A different solution has to be found, one that will respond to the need. The most obvious answer is to use a miniaturized version of the time line, divide it into the requisite units, and then label them. By cross-referencing to the text or captions, you can then describe the details without having to cut and squeeze.



A universal problem with time lines occurs when you have a lot of data in one area and little in another. To render graphically the history of humankind, for instance, requires a scale spanning millions of years, on which only the last 6,000 years get progressively

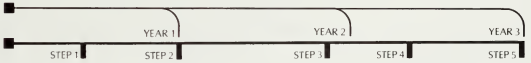
more crowded with essential facts. You either have to overcome the problem by making clever pictures like these



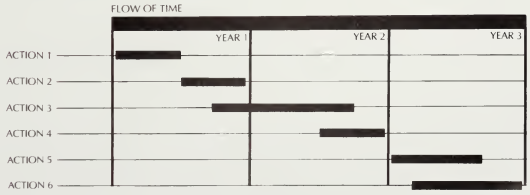
or you do the next most obvious thing—you change scales. Here you confront the fundamental problem of diagram making: Since your readers aren't as familiar with the material as you are, you must guide them toward understanding; therefore, any unexpected change needs to be flagged clearly and strongly, so that the viewer cannot possibly misinterpret the information.

Time-and-activity charts

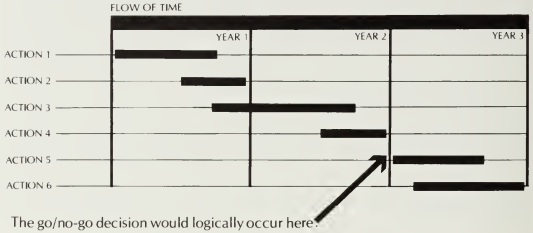
Time lines are usually devoted to reporting historic periods or showing sequences of events over time. But grafting the graphic principle of time lines to future projections can have useful applications in planning strategy.



Obviously, the complexity of such diagrams must depend on the information to be so organized. But, essentially, it is a question of deciding what the steps are likely to be, how long each is going to take, when each will probably start and end, and then plotting them against the time line. Each step ought to be shown on a separate line so that time overlaps can be accommodated clearly.

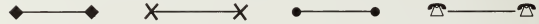


This simple principle is the basis for the Gantt diagram, which differs from what has been shown in merely one respect: the addition of one or more decision-making dates that are critical to the success or failure of the project. Such a pivotal point in time is identified by the fact that future actions cannot start until the actions preceding it have been completed. Clearly, the subject of the chart must be understood in order to determine such a point.



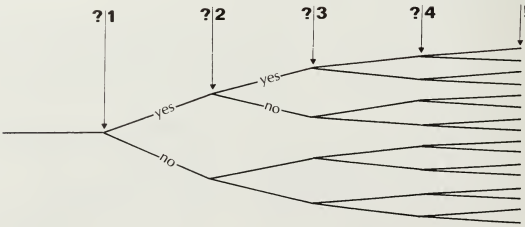
The go/no-go decision would logically occur here.

Gantt diagrams are evidence of coordinated thinking that breaks down a process into coherent segments and presents them in a consistent way so that the entire flow becomes intelligible and accessible. Naturally, like any kind of diagram, its communication capacity can be elaborated by adding symbols and keys.



The in-term for these symbols is "milestones" because they look just so, if you imagine the horizontal line to be a road leading from here to there.

One variant (or elaboration) on the time-and-activity chart form dispenses with the time scale; instead, it uses a scale in which each time interval or event becomes a departure point in two directions. It is helpful to think of each point as a question that yields a yes or no answer; to say *yes* is to follow one path, and to say *no* leads in the other direction. Each of these answers, which are similar to actions to be taken, in turn leads to further yes/no decisions that direct you on to the next set of questions. By studying the options presented in this sideways-growing tree, you can chart your anticipated actions and reach final decisions with greater clarity and security than you could were you to follow plain instinct.



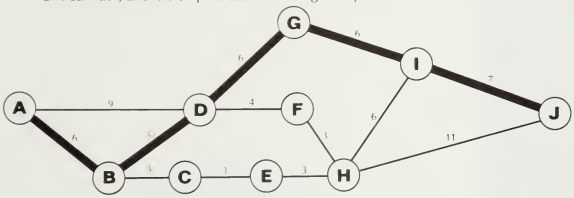
This is a rather special chart form, but it is shown here in the discussion of time-and-activity charts to make a point: You can always depart from the elementary purpose of a diagram and adapt it to a different end. This is an example of the malleability of chart

forms; they are not sacrosanct. Rather, they are just tools with which to analyze, study, understand, and communicate.

Another specialized diagram format that links events in terms of sequence as well as elapsed time is the CPM and PERT charts (CPM is *Critical Path Method;* PERT is *Program Evaluation Review Technique*). They are essential management tools for planning complex processes that require interactions by numerous producers whose efficiency will depend on ordering the events most logically. The great virtue of these charts is that they combine the succession of events clearly; often processes require parallel events to take place both independently of each other and in tandem during certain parts of their development. Charting such relationships allows them to be controlled in both sectors, as independent lines and as interconnecting processes that come together at the right point. This logic can be expressed visually because time lines are built into the system. Ordinary flow diagrams merely show linkages. PERT charts show the time scheduled for completion of each linking step because they are drawn to scale. Obviously, the units used in establishing the scale must be appropriate to the data. The nodes—typically numbered and keyed to a list because there are usually too many to label them all on the diagram—represent events or changes. The linking lines (shown to scale, with the number of units labeled for easy reading) represent the planned length of time for each event to materialize.

Since the lines vary in length, they cannot be drawn horizontally from left to right as a Gantt chart demands. Instead, they must be constructed in such a way that the radii of circles (of appropriate length) intersect others, so that the network is built up step by step, joint by joint, from left to right. It is a laborious trial-and-error process. Linked actions have paths joining them; independent actions have no paths joining them. That is what makes the figures such a useful management tool. Relationships that depend on each other are shown in the context of the complete process. And that is why the format is called the Program Evaluation Review Technique.

The process in the diagram is planned to take a given number of time units to complete. The path that adds up to the largest number of units—the one that cumulatively takes the longest—is, obviously, the one that all the other steps must be made to work with. If there is no such coordination, then delays will ensue, making the overall time expended longer than had been projected. This path is therefore known as the Critical Path, and it is emphasized in the diagram by a bolder line.



This primitive CPM diagram shows the principles in action. The system comes into its own with much more complex flows, where computer-assisted input becomes essential in their makeup.

■ Maps show a variety of facts, relationships, and information, and, like any other kind of diagram, they are a totally flexible medium of communication. They differ from all other forms of diagrams in that they represent shapes in some sort of spatial relationship. (If they didn't, they wouldn't be *maps*.) How those shapes and spatial relationships are utilized depends on the story's intended message, which you must analyze clearly, as well as your ability to convey that message in creative graphics.

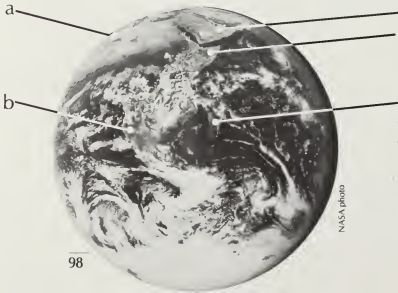
Imagination comes into play, for it is needed to blend the factual information — the shapes, sizes, proportions, and relationships — with an appropriate mode of visual expression that will enable the significance of those facts to emerge and reach the viewer's consciousness at first glance. Using maps, therefore, is an interpretive art form, and there's nothing cut-and-dried about it. It is challenging intellectually, enjoyable artistically, and fascinating journalistically, because so much can be done with it.

Before delving into some of the techniques, we must first make a clear distinction between two branches of this art. The first and seminal branch is the serious, dignified science of cartography. Here, accuracy and precision in the delineation of geography are essential. Cartography is based on millennia of research, calculation, effort, tradition, and honored accumulation of knowledge. It is a world of its own, and it provides us (communicators) with our raw material. The second branch applies cartographic techniques very (sometimes too) liberally to plot data for specific purposes. We use it as a background against which to impart information of quite different meaning and import than geographic precision. Because our aim is so very different, we can often allow ourselves crudities and inaccuracies, turning away from strict conformity to the cartographer's painstaking measurements and substituting a bowdlerized caricature. In our case, the end can be said to justify the means.

Maps as realistic pictures

What is the most precise, understandable, telling format for a "map"? A photograph. It couldn't be more realistic, nor could it make the facts more accessible to the viewer, for they are all spread out to view — undeniably *there*. Unfortunately, as all photographs do, photo maps show too much by showing everything. They need "editing" in order to become useful tools of communication.

Photographs can become useful depictions of the data we wish to communicate if the information can be pointed out in some way. Such emphasis can run the gamut from the basic verbal description in the caption to using color to distinguish various elements in the image. A simple and very useful — if all too rarely used — technique is to take the aerial photograph and run callouts to the elements being discussed.



The viewer's attention needs to be focused on the elements in the photograph that pertain to the subject of the story. Without such help, the interpretation of a general image such as a photograph is liable to too much subjective whim, since every viewer approaches images with his or her own background and interests.

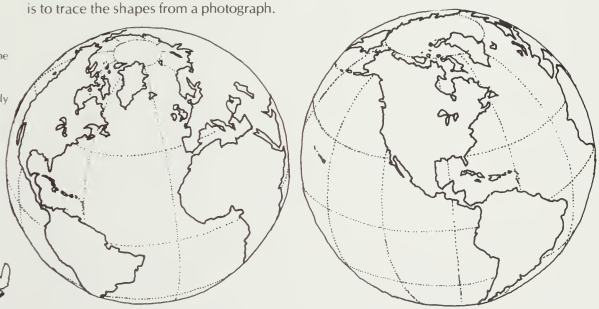
The illusion of flying in space and looking down at the globe can be duplicated by photographing a model. That's much better than even NASA's very best pictures because there are no clouds to obstruct the view. The model can show the wrinkles of the earth's crust at an exaggerated vertical scale to make the mountains stand out. It could be naturalistically colored or otherwise treated to make those features that are deemed important obvious by color. Such naturalistic/abstract treatment can result in a very telling image whose intent comes across to the viewer immediately. Its usefulness is not restricted to merely large areas shown at tiny scale, but applies to small areas just as effectively.

A globe photographed at two distances to encompass two different editorial meanings: a general overview and a specific detail.

Political divisions have to be overlaid onto the natural globe. Lines of demarcation between countries can be shown by drawn lines or by a mosaic of color areas.

Should a photograph of a globe be too detailed, you can substitute a drawing that simulates the same kind of rounded view. The easiest way of producing such an image is to trace the shapes from a photograph.

Two views illustrating the global view of the earth traced from photographs. The roundness of the planet is retained to communicate the context of the information, but specific details can be clearly emphasized in the drawing.



A word of warning may be in order here: We are used to seeing certain objects the same way all the time, and by becoming familiar with their shapes, we learn to recognize them at a glance. That's what makes such visual shorthand communicate. Interestingly enough, the orientation of those shapes is as important to our ability to recognize them as the shapes themselves. We must see them the same way for ease of recognition. That's why north ought always to be at the top. Otherwise, readers will have to orient themselves by means of visual landmarks (the Great Lakes, the Florida peninsula, Baja California).

Maps of the world seen as projections

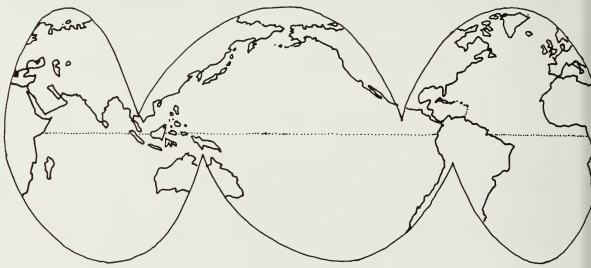
How do you take a ball — a sphere — and spread its skin onto a flat surface? How do you project the real curved shapes onto an unreal plane? That is a puzzle that has occupied cartographers ever since the earth's roundness was discovered to be a fact.

You can pretend that the earth isn't round at all, but a vertical cylinder, and unfurl the tubelike shape into a flat shape. Or you can pretend that it is an orange and peel the skin off in slices of various shapes and sizes, regular or irregular, to suit your purposes. Or you can distort it altogether in order to make the point.

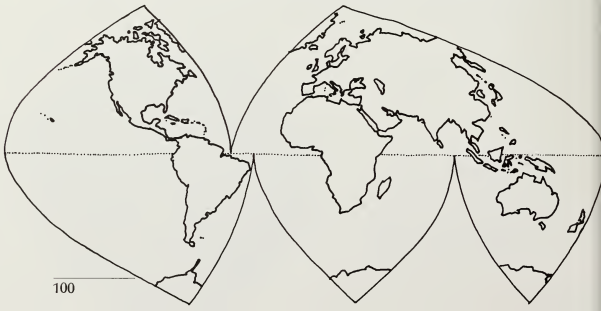
There is no ideal solution, since every solution represents compromise and demands some degree of exaggeration. Somehow, somewhere, some of the curved reality must become unreal in order to make the transformation to flatness work. That is why the choice of projection becomes an *editorial* decision — one in which interpretation and appropriateness to the message are the criteria. The question is basic: Which version tells the story we want to get across in the clearest, most forthright way?

Here are five examples to illustrate this editorial approach.

1. Let us say that you have a story about shipping on the world's sea-lanes. You would be foolish to use a map that breaks up the oceans; rather, you need an image that shows the seas as a smooth continuum (though it may, as a result, play havoc with the world's landmasses).



2. Let's assume your story deals with a road race from one side of the world to the other. The reverse of the previous example would apply: You would choose a map that shows continuous landmasses but sacrifices the oceans' shapes to achieve them.



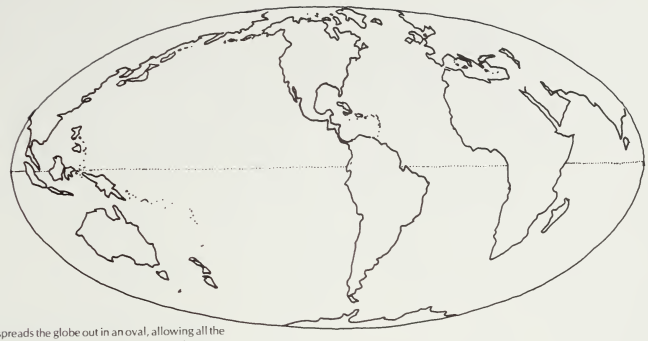
3. Imagine that we are navigating sailing vessels by compass in the temperate zones of the world, not too far north or south where danger lies. That is precisely the situation that Mercator faced in his mapmaking task. He produced the perfect answer—the projection we are most familiar with. The compass directions are quite correct throughout, and the landmasses are reasonably correct in the areas we are likely to travel (in our sailing ship). Beyond those areas, the landmasses become very exaggerated.

4. Let's assume that we need to show the comparative areas of the world's continents in an accurate way, while also showing where they occur in physical placement. The preceding projection shows the placement well enough, but suffers from exaggeration of the sizes of areas. The Peters projection seeks to overcome them by tampering with the familiar shapes: The northern and southern extremes are compressed, and the central section (about the equator) is also tightened. The image is startling, but the areas are in correct proportion.

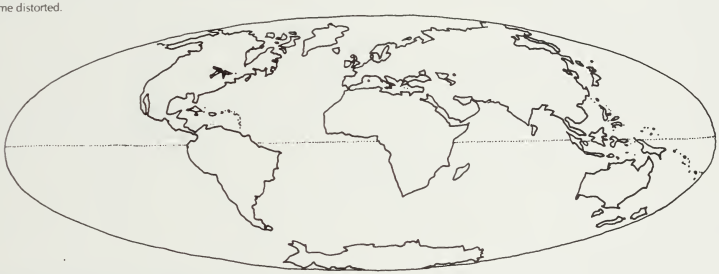
5. Consider the right map to illustrate a story on transpolar flight in the northern hemisphere. Obviously, you need a polar projection. But let's complicate matters just a little, and assume that you also need to show the relationship of the land in the southern hemisphere for complete understanding of the new routing. Here's a version that does display the continents in clear relation to each other, but that dismembers the South Atlantic completely in the process.

From these examples it is quite evident that the choice of graphic shape is based on story content—a criterion common to all diagrams, and should come as no surprise to the reader. To help you decide what kind of projection is ideal to your purposes, you have to know two sets of facts: what your story is, and what your mapping options are.

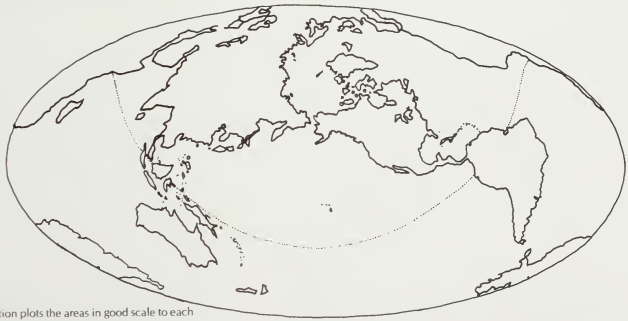
What follows is an overview of maps of the world drawn at different projections. This collection is by no means exhaustive, representing some of the basic maps and a few exotic ones to whet your appetite. You must pick from this selection whatever you deem the most appropriate to tell your story with. That doesn't mean the most "peculiar" or the most "dramatic" version, but rather the most telling one. They are annotated with names, so you can hunt down accurate, large versions in atlases. No suggestions as to their individual meanings or potential applications are made, specifically to keep your choice as story-directed as possible and to avoid misdirecting you.



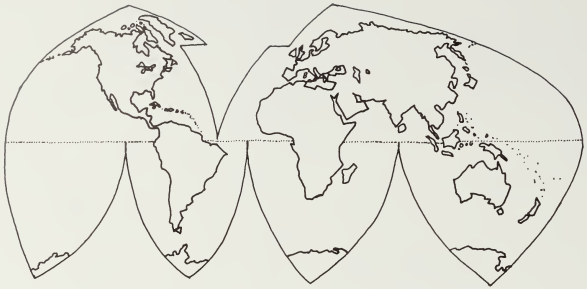
Mollweide's projection spreads the globe out in an oval, allowing all the landmasses to be seen. The drawback here is that the shapes at the outer edges become distorted.



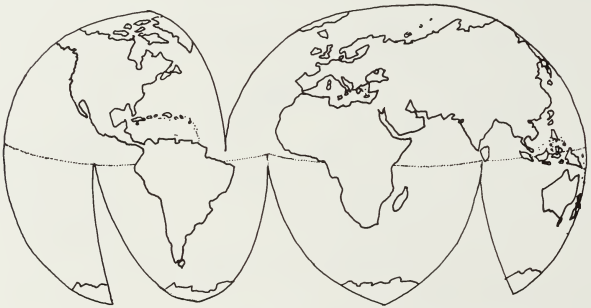
This variation of Mollweide's projection extends the oceans to the outer edges of the oval, which, in turn, allows the landmasses to be seen in their more natural shapes. The disadvantage here is that the bodies of water are exaggerated.



Bartholomew's Nordic projection plots the areas in good scale to each other, with the most accurate areas toward the center of the figure. It also shows shipping routes clearly. The disadvantage is hardly noticeable: There are two South Poles.



Goode's "interrupted" projection breaks up the oceans in order to allow landmasses to be shown accurately.



This projection is based on the same principles as Goode's, but it results in squatter shapes, for the globe is viewed from a point farther to the north.

This version of an antipodal (bipolar) projection changes the shapes of the oceans in order to keep the shapes of landmasses recognizable.

These two variations on the antipodal (bipolar) projection show both poles in one view. The one at left exaggerates landmasses to fit the entire figure into a circle; the one at right dismembers them to encompass full images of the oceans.

Azimuthal North Polar projections view the globe from a point above the North Pole. Here are two versions: The one at left accurately plots areas within a circle; the one at right retains the landmass shapes in more recognizable forms by ignoring the shape of the oceans that surround them.

Three versions of azimuthal projections, in which both poles are visible, are shown here, each with a different focal center: New York, Paris, and Tokyo. Since the area around each center is the most accurate and the areas closest to the outer edges are the most exaggerated, any decision to center the basic view must be motivated by editorial concerns. Thus, if this projection helps you to make your point, by all means use it.

World maps stylized

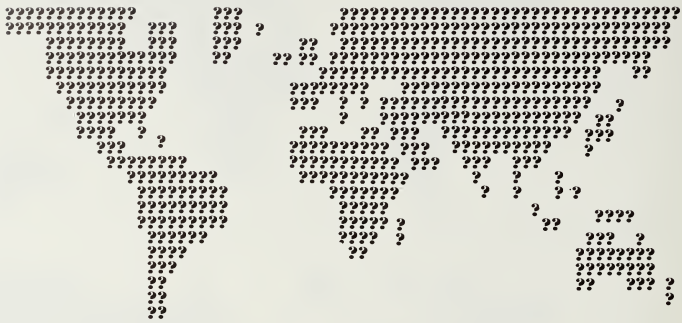
Often the general idea of the map is more important than the geographic details. All you want the viewer to do is to recognize the continents by their general shapes and positions. Under such circumstances, you can render these familiar shapes in a way that not only simplifies their outlines but makes them more self-consciously special. Such geometry can yield the requisite shapes, yet dress them in startling costume. Here are three versions.

The world drawn with straight lines in vertical or horizontal directions only.

Here lines at 45° have been added to the verticals and horizontals in the previous version.

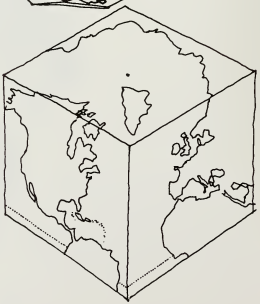
The map rendered in 60° and horizontal lines.

The texture of areas can be used to give an image its own special meaning. Making the shapes from repeated letters or symbols yields a special effect full of its own meaning, as in this example.

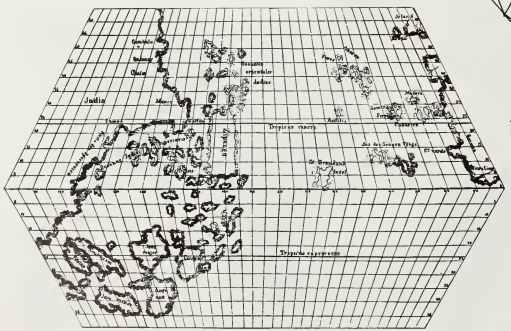


The geometrical configuration of the sphere can also be altered to make a point—after all, there was much concern lest Columbus's ships fall off the edge.

The globe as a cube and as a polyhedron; the startling geometry is understood to be false, yet the shapes drawn upon it are within reason and acceptable.



A version of the map Columbus had. Japan (Zipangu) is right across the Atlantic from Europe.

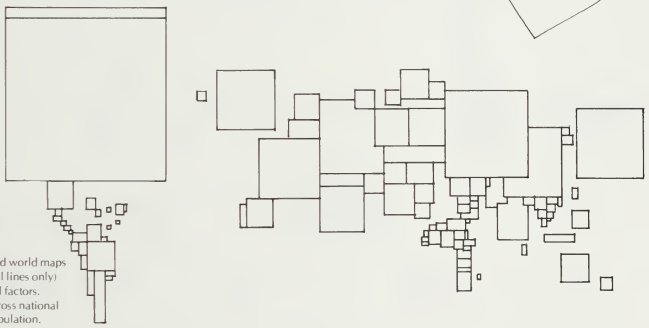


World maps distorted

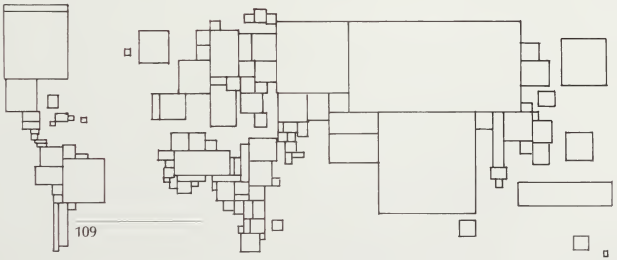
We expect geographic entities to have "correct" shapes and sizes—those we are accustomed to seeing. Unexpected alterations of proportions are startling. If, however, we purposely tamper with reality in order to make specific points, we can play on such reactions and produce unusually vivid communication.

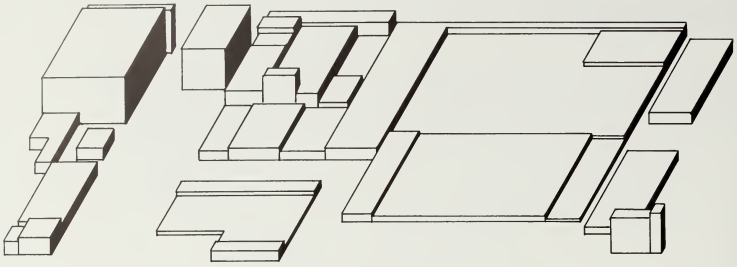
Such combinations of data with altered proportions or dimensions cannot, of course, be statistically accurate. They can, however, reflect general notions or biases: An area of the globe that is more important than might be expected despite its usually small size can be drawn out of scale (or much bigger than usual) in order to make the point visually. Needless to say, the same point must be made verbally in the accompanying caption or headline.

The natural shapes have been simplified and landmass sizes exaggerated to reflect comparative data. (Here oil production might be the subject.)

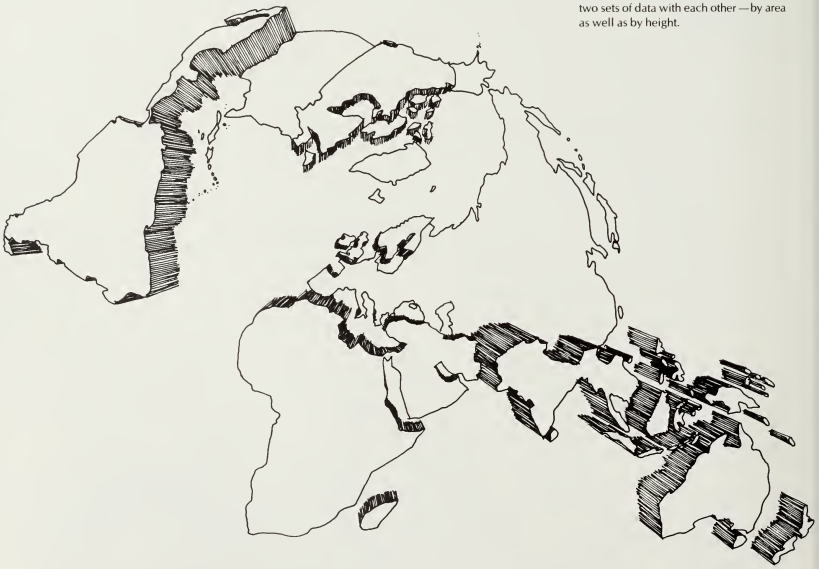


These two versions of stylized world maps (using vertical and horizontal lines only) reflect two kinds of statistical factors. The one at right compares gross national product; the one below, population.





Rendering exaggerated or stylized shapes and sizes in three dimensions as though they were blocks allows you to compare two sets of data with each other — by area as well as by height.



You can show the amount of a commodity by giving the area a thickness in proportion to the amount, even on an unusual projection such as this one.

Maps as background to statistics

Frequently, we are presented with a situation in which a map is a given factor whose sole function is to locate data for which it forms a backdrop. In such cases, a map needs to be edited down to the essentials — it can be abstract or it can be extremely naturalistic. But its secondary role has to be understood and expressed.

In order for it to be superimposed upon this backdrop, then, the data relating to each area of the map must be represented by graphic symbols as expressive of the subject and as legible as possible. These symbols must be fashioned so that the largest item of data can fit into the smallest geographic area; once you have solved this problem of relationship of sizes, all other symbols of data are bound to fit in. There is no question that it requires imagination and sheer hard work to find that combination, but the effort is well invested; it avoids the frustration of trial-and-error repetition that results from starting the process of charting without a plan.*

Which graphic symbols you choose to represent the data depends, of course, on circumstances. You may opt for bars or columns, using their lengths to demonstrate comparative amounts. Or you can use dots and circles of varying diameters to denote various amounts. (Such dots can be halved into semicircles, or even turned into pie charts, should you need to indicate several sets of related facts.) You can also turn your geometric symbols into three-dimensional solid shapes to produce picturesque drama. Or you can invent symbols specifically suited to the subject and present them in mosaiclike repetition. Color and/or texture can be used to highlight areas of greater or lesser importance. The possibilities are limited only by your imagination.

Circles of various sizes . . . dots divided into hemispheres for comparison . . . columns or bars in varied groups . . .

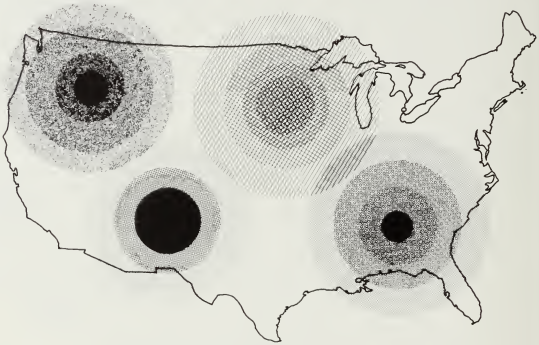
columns three-dimensionalized to "stand" on their appropriate locations . . . naturalistic or pictorial symbols . . . anything that tells the story is appropriate as symbolic material atop maps.

Whichever symbols you choose, you must make certain that they are all clearly and unequivocally identified. Small dots may look attractive in patterns, but they communicate little unless the viewer understands the scale by which they are measured and what each shape stands for. Therefore, proper identification in the key and scale is as essential to understanding as the title of the diagram. Resist the temptation to hide keys and diagrams in some corner because "they are a disturbing element" or "unsightly" — the diagram exists to clarify communication, and making the viewer dig for meaning defeats its purpose. We must do whatever we can to propel

*You can avoid problems of fitting by making the map a "key" diagram — quite small — and showing the graphic statistics in the surrounding space; arrows can point from the statistics to their location on the map. See pages 32 and 167.

the message off the page and into the reader's mind quickly, smoothly, subtly. Crucial to that purpose are clarity, legibility, and visibility in the presentation and placement of the key, explanation of symbols, scales of measurement, labeling, and the like. They should be built up as important features and given pride of place.

To illustrate the principle described here requires one simple diagram, for the *idea* is simple indeed to understand. The quality of the rendering of the idea as applied to your specific needs and circumstances will be what makes your diagram a telling example of communication.



The United States is shown here with four hypothetical centers of influence; the centers of heaviest concentration are darkest in tone, with paler and paler tints representing decrease of influence as distance increases from each epicenter.

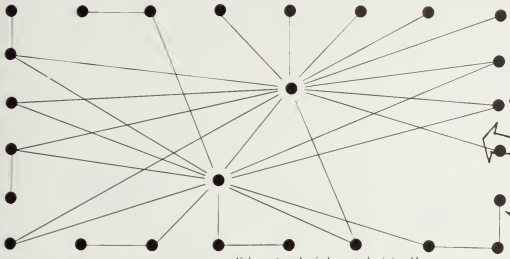
Maps as background to movement

Distances, directions, amount of flow, relationship between places, sequences of stops along a route—all of these and more can be mapped. They all require some sort of visual as well as spatial rendering to explain the facts; however, the extent to which the rendering should be realistic or detailed depends on the complexity and quantity of the data. A meticulous map may be inappropriate, because its comprehensiveness may well obscure the message you are trying to relate. The degree to which fixed geographic positions can be moved around or the image simplified is clearly a function of the circumstances in each situation as revealed by the editorial purpose—the reason for showing the diagram. Suffice it to say that tampering with reality is a legitimate technique if the result helps you to communicate. If you are distorting realistic representation just to make the result look startling, then such peculiarity of expression may well impede communication in much the way that too many extraneous details can.

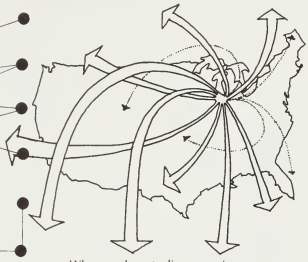
The map as background to movement, then, can be seen as a totally flexible diagram format; realistic depiction of an area can be just as telling, used in an appropriate situation, as a stylized one in its situation. It may well be perfectly acceptable to draw the arrows to targets that would be in the right place if there were a map there, but leave the map out altogether—assuming that the viewer's knowledge of relative placement of those targets will make the proper connections in the imagination. It may even be acceptable to distort the placement altogether and show a diagram whose sole purpose is to plot the sequence of stops along a route. For

instance, the traveler need not know whether the vehicle in which he or she is being carried will turn left or right; all he or she cares about is which station will be next.

Here, then, are six such diagrams, each of different form devised to express a different purpose.

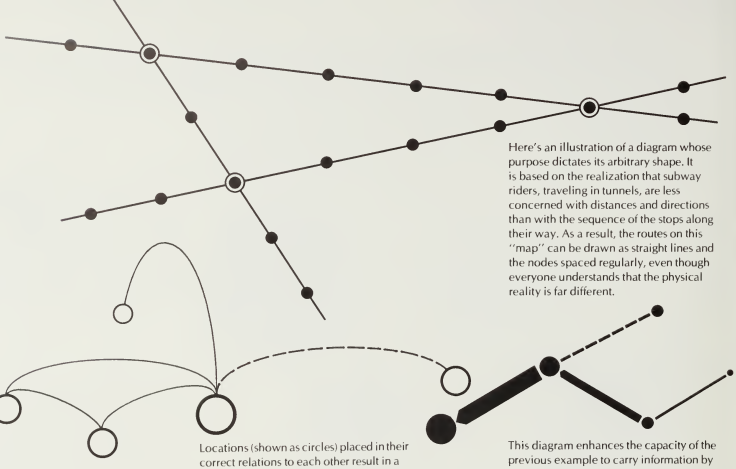


If the network of places to be joined by lines is large enough, and if the places are well known enough not to require precise pinpointing on a map, and if the audience is likely to understand the symbolic nature of the "map," then highly decorative figures can be constructed. (Airline route maps are particularly interesting in demonstrating this technique.)



When you have to diagram an image in which there is a central point from which relationships emanate outward to surrounding points, arrows can be used to great advantage, for their very shape implies the active transfer of influence from one place to another. Here the locations of the places are assumed to be well known enough to make the outline of the areas unnecessary — the map is implied. The diagram emphasizes an editorial message: This is a story about influences radiating outward from a single source.

A naturalistic (i.e., recognizable) rendering of shapes is shown in this example. Note how important such depiction becomes when a complex series of relationships needs to be illustrated. On the other hand, it also demonstrates that realism need not impede symbolic thinking *in the same figure*. It is safe to assume that the viewer will not take some of the routes indicated by the arrows as literally true. (Would Britain be likely to ship goods to the West Coast of the United States via West Africa?) This type of map is symbolic, showing theoretical relationships, not the movement of goods. Therefore, relationships that appear absurd when taken literally become acceptable, even sensible, given the right context.



Here's an illustration of a diagram whose purpose dictates its arbitrary shape. It is based on the realization that subway riders, traveling in tunnels, are less concerned with distances and directions than with the sequence of the stops along their way. As a result, the routes on this "map" can be drawn as straight lines and the nodes spaced regularly, even though everyone understands that the physical reality is far different.

Locations (shown as circles) placed in their correct relations to each other result in a more realistic variant on the preceding diagram format. This diagram can be enriched with further information by making each circle correspond to the relative importance of its subject.

This diagram enhances the capacity of the previous example to carry information by expressing the degree of importance of the lines connecting the points; this is done by varying the thickness of the arrows that join them. Combining these three preceding techniques could result in a diagram rich with information.

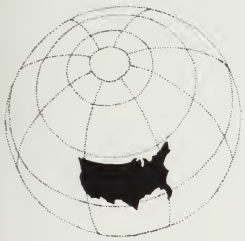
Maps as illustration

Nothing is easier—or duller—than illustrating a story with a map; even elementary school children embellish their reports that way. It is one of the most obvious means of imparting basic information while adding an element of visual interest.

The realization that a map can be used to depict more than geographic locations and relationships makes it possible to advance beyond a third-grade level of communication. There are several advantages to taking the expected image and turning it into an unexpected one:

1. You gain attention.
2. You add interest where otherwise there would be little.
3. You clarify the point you're trying to make in the very process of deciding how to suit the image to your needs.
4. You make the most of an opportunity by giving the graphic element the size and visibility it warrants.
5. You derive the greatest benefit from the investment in time, care, effort, and money by producing something that adds meaning and depth.
6. Your publication or report gains stature through the effectiveness of the map's journalistic value and design.

To illustrate the thesis that a map, any map, can be more than the expected cliché, here is the most common image of all (the outline of the United States) handled in a number of ways. It is malleable raw material, ready to be shaped to our purposes. Its shape is so well known and so easily recognized that we can take all sorts of liberties with it with impunity.



The area in its context on the otherwise empty globe. Imagine how intriguing this image would be if it were not shown as a sketch, the way it is seen here, but if it were sculpted as a globe showing the lines of latitude and longitude incised into its surface, and the little United States carved in bas-relief on the surface.

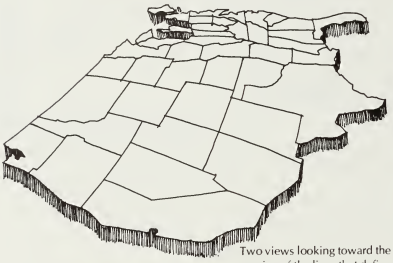
The illusion of thickness that turns a thin, flat sheet into a slab adds color and interest.

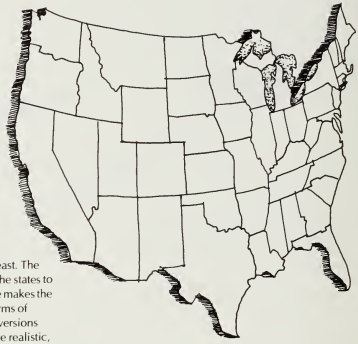
It may be difficult or inappropriate to make the map itself into an object with dimension. A similar effect can be achieved by making the background — the board on which it is printed — appear three-dimensionalized.

In aerial views, the height from which an image is seen affects its shape and proportion. The lower the view is, the more dramatic the distortion will be. These three maps were drawn at three different heights. Turning them around so they stand vertically yields yet another effect.

Turning the aerial view at a slight angle enables you to draw attention to the area closest to the viewer. Here the aggressive thrust forward of the Florida Peninsula makes this view a disturbing one.

Even with the outlines of the states indicated, this map is not very exciting, because of its flatness. It needs some "color." It might get that by thickening the edges or by tinting the states in different tones.



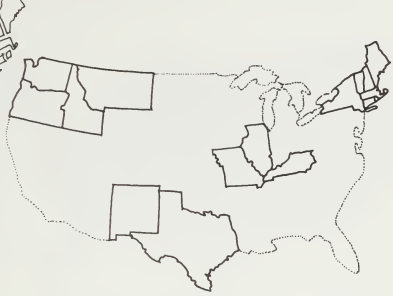


Two views looking toward the east. The curving of the lines that define the states to follow the curvature of the globe makes the image far more interesting in terms of graphic interpretation than flat versions using straight lines. It looks more realistic, less diagrammatic, more pictorial, less abstract.

Instead of taking a frontal view, you could pretend you were flying in space and were looking at the map from your approaching angle. Not only does that make the image more interesting, it also allows you to "weight" the areas in view by their importance. Imagine that you must accommodate a great many items in the New England area, but just a few in California. Seeing the map from the east makes New England much larger, and perspective makes California appear tiny in the distance.

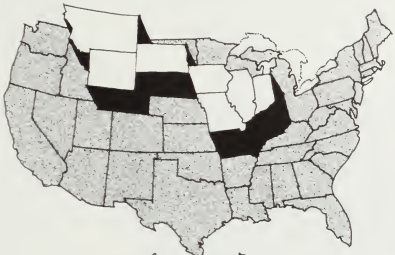
However, there's a big difference between showing a map in perspective and just squeezing it. The drawing at right is an example of such arbitrary compression: The vertical scale used to plot the north-south dimensions is larger than the scale used to plot the east-west ones. The resultant caricature looks peculiar, because it is not based on "natural" proportions. That's why it looks wrong. Because the steeply angled view at left appears to vanish to a proper vanishing point (getting smaller as it appears to recede in the distance) and therefore looks normal, the actual distortion is perfectly acceptable.

Dismembering the states by separating them gives you an opportunity to draw attention to individual elements in some way: by using color or tints of gray, adding symbols, pulling one or more of the jigsaw-puzzle pieces out from the group, and so on.

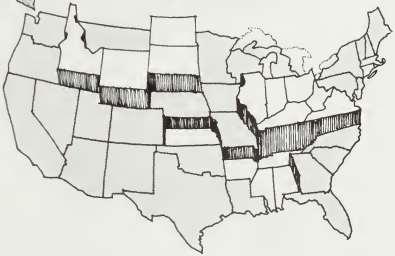


To emphasize specific areas, just draw in the ones discussed in the story, leaving the rest of the figure blank.

To bring attention to areas of importance, you can build them up as blocks rising above the surface of the surrounding map . . .

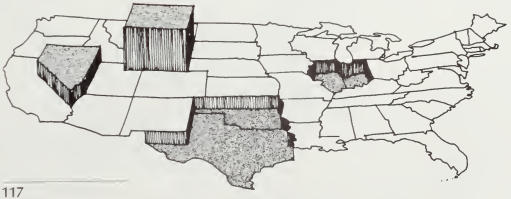


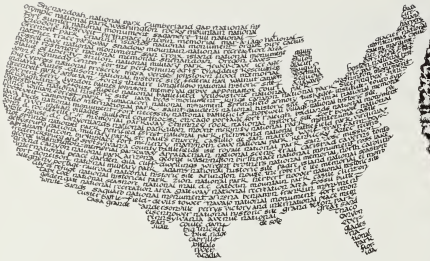
or sink them below the level of the surroundings . . .



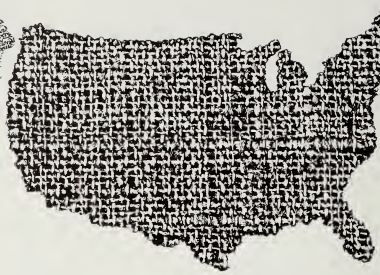
or combine the two techniques in an upheaval of natural forces . . .

but it is most effective to show levels on a map that looks at the entire area from a lower angle. Maps that build accurately contoured peaks and valleys based upon statistical data are now commonly produced by computer-imaging technology.



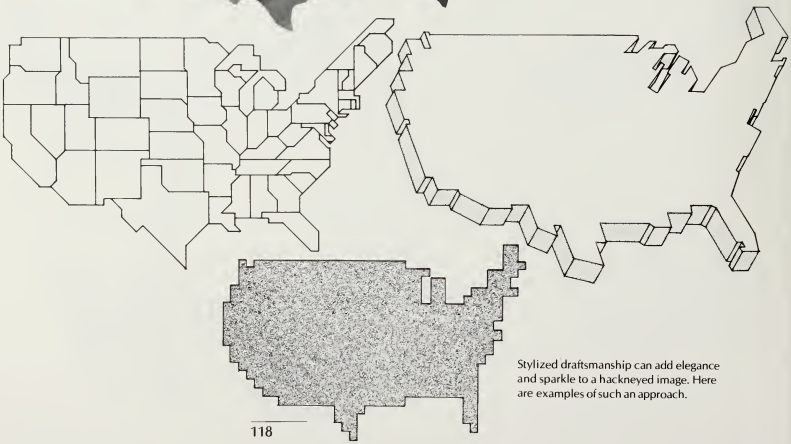


The texture of the map can be used symbolically to lead the viewer to an understanding of the meaning and purpose of the image. Here the names of national parks and historic places are composed into the encompassing shape of a map by calligrapher Bride M. Whelan.



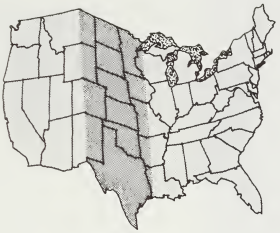
By contrast to the preceding hand-engrossed example, photography can also be used to combine form with content. You can take any flat material (such as this sackcloth), cut it into the requisite shape, and then photograph it. Any material — plywood, ice, brick, apple pie, steak — can be made to work if it illustrates your point effectively.

It is always possible to cut a photograph in the shape of a map. The problem is merely finding the right kind of picture, for not all will do (quite apart from the subject matter, of course). The photograph needs to have a simple image as well as a dark and consistent tone, so that the outline by which the map shape will be recognized is unmistakable.



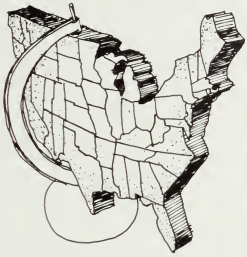
Stylized draftsmanship can add elegance and sparkle to a hackneyed image. Here are examples of such an approach.

The map can be shown as a picture of a map. The idea of such "map-ness" is clearly signaled when the image looks as though it were the creased and folded object found in every glove compartment.

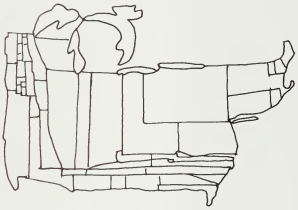


Here the outline of the paper on which the map is printed has been dispensed with, and the folds and creases are shown in the way the map itself has been drawn.

If a sheet of paper can be folded, it can also be rolled up. Here's a map apparently rolled up, leaving only the part you wish to have seen open to view.

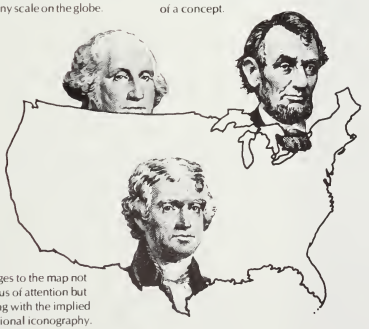


If the map were carved from a solid block, it might well be held in an armillary sphere support. Compare the apparent meaning of this diagram, where the United States is all, with the first diagram in this series, where it is also alone, but in tiny scale on the globe.



This is, of course, a caricature, but it has a point. One area is very important. No one is expected to accept this as an accurate rendering of data; the viewer will, however, understand it as the illustration of a concept.

Hands are always useful enliveners of images; they are nearly as expressive as faces. Adding them to a map can work wonders in pinpointing centers of importance to the story.



Adding external images to the map not only makes it the focus of attention but also enriches meaning with the implied allusions of the additional iconography.

■ Arrangements of facts in formalized relationships —whether they are expressed in words or in an abstract visual format —are diagrams of a special kind. They range from the simplicity of an itemized list, through ciphered lists such as timetables, to complicated buyers' guides that analyze competing products in terms of qualitative rankings by means of abstract symbols. They encompass an immense variety of forms and inventive iconographies, yet a*ll must obey some fundamental rules of common sense.*

1. They must have a clearly stated purpose.
2. They must have a physical shape that organizes data effectively so that the data's purpose becomes self-evident.
3. They must be typographically clear and legible.
4. They must be arranged neatly.
5. They must be attractive as images.

Yes, what you have just read is a *list,* and a list is the most primitive of diagrams. A number of attributes define a list and make it listlike at first glance. For one, the items are written the same way —each starts with a repetitive "they must." Further, a neat presentation calls for them to be of similar length —something that item 2 fails to fulfill, so this may be called a poor list! Also, each item is placed on a separate line and is numbered (if the items are part of a coherent series) or bulleted (if the collection is random). The items are also indented, to make the group stand out from their surroundings. A list should also be preceded by a sentence explaining what the following list is all about; ideally, such a sentence should be set off in typographic "color" in some way, for its importance is crucial to the velocity of communication. It is fairly common practice to precede and follow a list with a little extra space to separate it from the surrounding text, thereby identifying it in an isolating frame. Standard typographic practice used to be, now happily being supplanted by logic, to set lists a size smaller than the surrounding copy. After all, the list contains material as essential as the rest of the text, if not more so, and it should therefore be as legible and thus the same size as the rest of the text —but tradition dies hard.

Verbal tables

When your list is condensed from a series of verbal statements in sentence form into a formalized presentation of facts in words, numbers, or symbols, you are making a tabulation. A true table is one in which two or more factors referring to an item are shown for comparison, and a third piece of knowledge can be found at the points where the horizontally and vertically arranged data intersect.

The groupings —aligned vertically or horizontally —are organized by some logical relationship to the subject. The only challenge is to devise headings for each column that will clue the viewer immediately to the subject matter.

Name of item	*Factor 1*	*Factor 2*	*Factor 3*
AAAA	00	000	0000
BBBB	0	0000	00
CCCC	000	0	000
DDDD	00	00000	000000

Designing tables is as much a process of graphic expression as is turning data into visual symbols. It is an undeniable fact that table making traditionally has been looked down on as an activity to be relegated to the typesetter, who, being the last person in

the manufacturing process, cannot get rid of it by foisting it on someone else. It is, indeed, a sometimes tedious business but, nevertheless, an area where opportunities for graphic variation as well as expression are there for the seizing. Just think of what you can do with spacing, positioning, framing, emphasis by color or boldness of type, embellishment with rules of various weights, and so forth. Yet their potential is seldom utilized. Instead, the traditional norms are unthinkingly followed. Take, for example, the problem of column spacing.

Name of item	*Factor 1*	*Factor 2*
Aaaaaa	00	0000
Bbbbbb	000	000
Cccccc	0	00
Dddddd	00000	0000

Since vertical groupings of narrow elements (which is what tabulated columns look like) are so much easier to discern on the page than horizontal relationships, they tend to dominate the image visually. Yet reading across the table is as important as reading up and down the columns. By separating the columns and leaving wide gaps between them, the horizontal reading direction is impeded. The chief task in making a table easy to read is to bridge those gaps as effectively as possible so that the two reading directions (up and down and left to right) come into balance.

The simplest technique is to bring the columns together as close as the headings atop the columns permit. Because these headings are usually much longer than the

Name of item	*Factor 1*	*Factor 2*
Aaaaa	000	00
Bbbbb	00	0
Ccccc	0000	0000
Ddddd	0	000

numbers below them in each column, we tend to follow the common, albeit foolish, practice of making the column as wide as the text atop it. We force the reader's eye to leap across vast areas of emptiness, hoping it will alight at the right place on the other side. That may or may not happen. Using leaders (or . . . . . .) to create tracks to follow from one side to the other is only a second-rate solution, reminiscent of machine-gun bullet holes in a wall.

Name of item	*Factor 1*	*Factor 2*
Aaaaa	000	00
Bbbbb	00	0
Ccccc	0000	000
Ddddd	0	000

To facilitate the sideways motion of the eye, it is also advisable to space out the lines vertically with generous "leading" or spacing between the lines of type.

Name of item	*Factor 1*	*Factor 2*
Aaaaa	000	00
Bbbbb	00	0
Ccccc	0000	0000
Ddddd	0	000

Should such extra spacing use up too much space, a tighter arrangement is possible if you run hairline rules between the lines to separate them visually.

Name of item	*Factor 1*	*Factor 2*
Aaaaa	000	00
Bbbbb	0	0000
Ccccc	00000	0
Ddddd	00	000

If a great many items need listing, then perhaps the preceding solutions are too much of a good thing. In that case, leaving an extra-wide space following every fourth or fifth item might do the trick. Or you could run every other line in a second color (blue is usually very successful). Or you could strip a pale screen of black—a very light gray—over every other group of three lines.

The inner geometry of tables is another area rich in possibilities for making them faster to scan and understand. The arrangement of elements in the columns has an intimate relationship with the surrounding space, and blank space (that which is left over after the type has been put in place) is as much an element of the design as are the printed marks themselves.

It is traditional to center headings over columns. There is nothing wrong with this placement, for it is quickly understood by the viewer. It also works well when you have only a column or two. But when you have more, and when they are in close proximity (as they should be), the space between them affects the way the table looks and reads. Centering the headings leaves ill-defined small snippets of space that vary in size according to the lengths of the words in the headings. The columns of data are spaced at regular intervals, but the headings on top of them obviously vary. As a result, the top of the table, where the headings are, tends to look disorganized and messy.

Name of item	*Magnitude*		
	Dimensions	Size	Outer measurements
Aaaaaa	000000	0000000000000	000000
Bbbbbbbbbbbbbbbbbbbb	000000	0000000000000	000000
Ccccccccccc	000000	0000000000000	000000
Dddddddd	000000	0000000000000	000000

If all the headings were set flush left, however, then the left-hand edge of each column would become a hard, crisp, precise edge from which all the words and numbers spring. The left-hand edge—or rather the series of left-hand edges—yields an image of precision, organization, and clarity.

Name of item	*Magnitude*		
	Dimensions	Size	Outer measurements
Aaaaaa	000000	0000000000000	000000
Bbbbbbbbbbbbbbbbbbbb	000000	0000000000000	000000
Ccccccccccc	000000	0000000000000	000000
Dddddddd	000000	0000000000000	000000

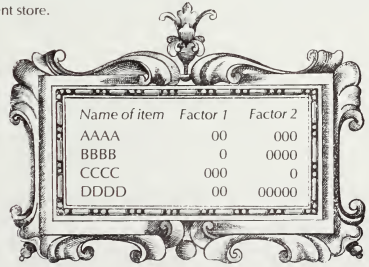
Also, column heads ought to be condensed in order to make them as narrow as practicable. This compression can be accomplished by picking short words, using judicious abbreviations, setting them in condensed type, stacking words in several lines, or placing them sideways or at an angle.

LONG HEADING RUN SIDEWAYS	LONG HEADING RUN AT AN ANGLE	THIS IS A VERY LONG HEADING FOR A TABLE	THIS IS A VERY LONG HEADING RUN STACKED	THIS IS A VERY LONG HEADING SET IN CONDENSED TYPE
000000	000000	000000	000000	000000
000000	000000	000000	000000	000000
000000	000000	000000	000000	000000
000000	000000	000000	000000	000000

To help give the table a crisp, rectangular shape—to foster an impression of carefully crafted precision—you can set a bold rule across the top and bottom edge. Such a rule defines the space, adds decorative and enriching color, and articulates the edges. Or, alternatively, you can put the table inside a box, run a pale tint over the area it occupies, or use any of the suggestions in the chapter on frames.

Name of item	*Factor 1*	*Factor 2*
Aaaaa	000	00
Bbbbb	0	0000
Ccccc	00000	0
Ddddd	00	000

Tables are just as much "illustrations" as are pictorial representations of statistical data, and so they deserve similar treatment. That is especially so when you have a mixture of tables and diagrams in one report. The richness and impressiveness that such homogeneity imparts to the result yield an effect far greater than you imagine. It is, of course, partially superficial window dressing to attract attention—but that is merely a facet of salesmanship. Its efficacy is as essential to "selling" ideas from a printed page or slide presentation screen as it is to selling haute couture in a department store.



Name of item	*Factor 1*	*Factor 2*
AAAA	00	000
BBBB	0	0000
CCCC	000	0
DDDD	00	00000

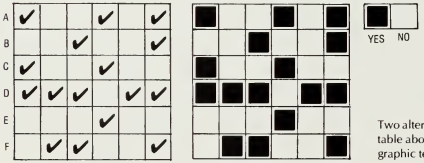
The essence of a table is that two sets of facts be compared in a clearly organized, consecutive manner. The information needs to be so edited and simplified that it allows such presentation in a natural, coherent way.

Verbal/mathematical tabulation (merely an elaborate listing, as discussed earlier) is the image that comes to mind immediately when the word "tables" is mentioned. However, that is too narrow a view, given the general definition of the essence of what a table is. It is perfectly appropriate to think of tables as being essentially graphic, or at least a blend of verbal and graphic communication.

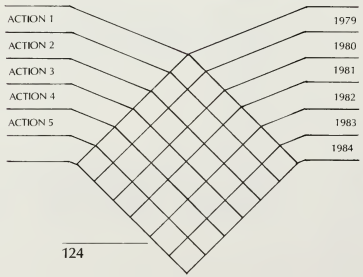
How often have you seen diagrams that show facts about who does what, where something is to be found, which of the many producers make it, what the options are? They are everywhere. And they are *graphic* tables. They are yes/no tabulations in which "criteria" (the what) are plotted vertically, and "locations" are plotted horizontally. (Obviously "criteria" and "locations" are merely terms used here to describe two sets of factors; you can compare just about any two items in these tabulations.) The body of the table is broken into a grid of pigeonholes, and each is filled with the appropriate *yes* or *no*, depending on whether the particular criterion is available at that particular location.

CRITERIA	LOCATIONS 1	2	3	4	5	6
A	YES	NO	NO	YES	NO	YES
B	NO	NO	YES	NO	NO	YES
C	YES	NO	NO	YES	NO	NO
D	YES	YES	YES	NO	YES	YES
E	NO	NO	NO	YES	NO	NO
F	NO	YES	YES	NO	NO	YES

A typical graphic table is shown here with the "criteria" (the what) and the "location" (where) labels heading the two sets of data being tabulated.

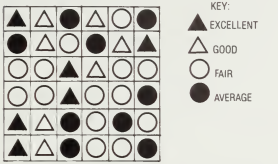


Two alternate ways in which the field in the table above can be handled using different graphic techniques to say the same thing.

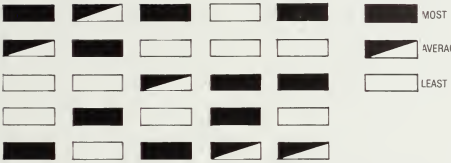


The table has been turned at an angle, allowing the lettering to run horizontally on both sides. Such an unexpected placement of an ordinary image catches the viewer's attention, especially if it is large and important enough —i.e., if it has enough items to make such a *tour de force* worthwhile.

If, instead of using the word "yes" or solid boxes, you insert symbols that stand for degrees of excellence, you can add a dimension to the information that makes the image far more useful. It is no longer a checklist or tabulated index, but becomes, rather, a fast-reading comparison of choices on which decisions can be based.

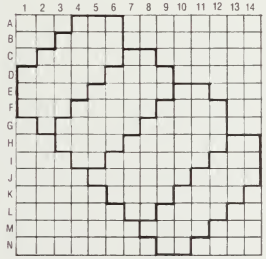


Symbols representing degrees of excellence, or whatever other ranking may be appropriate, can be inserted in the pigeonholes and thus enrich the capacity of the diagram to impart information.



To avoid the complicated graphics of the pigeonhole grid, you can use symbols that define the field and its geometry by their own rectangular shapes. Although the resultant diagram looks simpler, it is no more difficult to understand than if the grid lines were there. To make sure that this be so, make the rectangles wide enough to leave space at the top for the column headings and separate them widely enough.

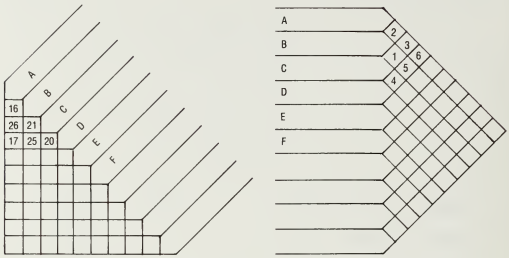
Where ranges of elements within a graphic table can be usefully combined to show their relationships, an adaptation of the tabular index can be made. In the diagram that follows, four sets of factors are defined by bold outlines around each group, and their difference is emphasized by a light tint over alternating areas. Clearly, the shapes are not arbitrary, but represent a range of items available in different size proportions. (Let's say that you can buy it in brown if the size D3 will suit you, but is not available in size B2; it is also only available in pink, should you need it in D6.)



A concise listing of a large number of items ranging over a wide choice of proportions (vertical/horizontal axes) and organized into four groups, each adding one more dimension of information to the yes/no basic answer implied by the filled-in or empty rectangle.

Where only a single list of criteria but a large number of interrelationships need to be shown, it is appropriate and easy to make a half-chart. This form is often used to show distances from one place to another. The way in which the figure is placed on the page affects its interpretation: With the pigeonholes on the horizontal and locations on the

diagonal, it is the numbers inside the pigeonholes that are the dominant elements, for they are easier to read. On the other hand, when the names of the places are listed on the vertical, the numbers become secondary.



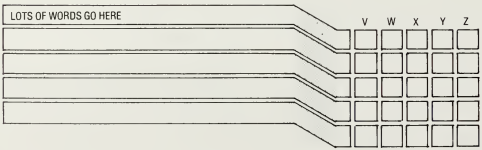
Mileage diagrams are based on the yes/no relationship, substituting statistics for the factor of "availability" in the grid.

The problem of too many words in tables

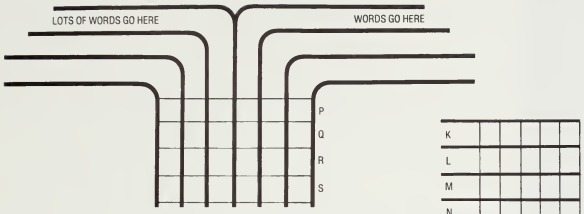
In the rather vague area where verbal description and visual arrangement meet, there is but one principle on which to base decisions: *anything* goes. There are no rules, except your judgment, as to whether the verbal/visual solution tells the story so that the viewer will understand it and whether the verbal/visual arrangement does justice to the material. That is why you have to understand the substance. That, also, is why you have to exercise restraint, for you must prevent graphic fireworks from interposing themselves between the viewer and the message.

By the same token, it is often necessary to accommodate column headings that are much too long for the "normal" way of handling such elements in a chart. Often they cannot be condensed without distorting their meaning. That's when the "anything goes" philosophy comes into its own, for it is in situations such as this that creativity comes properly into the picture. Every problem carries within itself the seeds of its own solution. If that solution makes sense in terms of the story's content, then it becomes the *right* solution, whatever form it may finally adopt: traditional or unexpected.

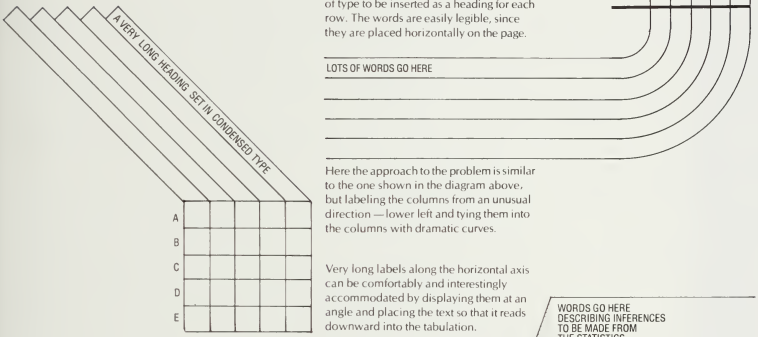
Here are some interesting ways of accommodating column headings of enormous lengths that make a virtue of necessity and thus help to make the tables they are a part of as informative as they need to be. They are also, not accidentally, graphically very startling images. Such a combination defines what good communication is.



To accommodate very long descriptive labels in the vertical row, the entire figure has been drawn as a series of ribbons; the gray "bend" underscores the peculiar shape and makes the length acceptable — (and visually amusing).

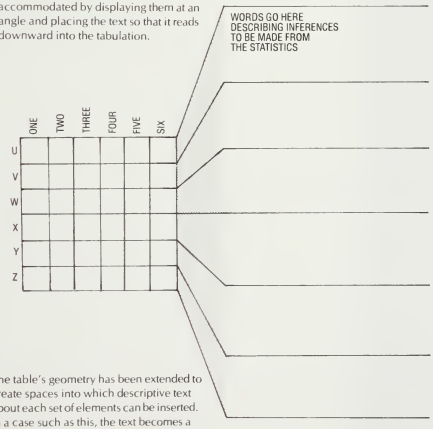


Creating staggered and folded spaces tied into the table allows more than a single line of type to be inserted as a heading for each row. The words are easily legible, since they are placed horizontally on the page.



Here the approach to the problem is similar to the one shown in the diagram above, but labeling the columns from an unusual direction — lower left and tying them into the columns with dramatic curves.

Very long labels along the horizontal axis can be comfortably and interestingly accommodated by displaying them at an angle and placing the text so that it reads downward into the tabulation.



The table's geometry has been extended to create spaces into which descriptive text about each set of elements can be inserted. In a case such as this, the text becomes a second tabulation integrally joined to the more graphic one.

9: FRAMES AND BOXES

■ Any document or publication that is likely to use a lot of diagrams should have a "house style." Developing such a set of "do's and don'ts" requires a lot of forethought as well as investment. Yet it is worth every effort, for these reasons:

1. To ensure that the consistency of images builds up in the viewer's mind to an agglomeration of unified impressions. That way the value of these images is greater than their sum—and that's a positive quality in anything that entails an outlay of treasure.

2. To allow the many diagrams to contribute actively to the overall image of the product. The way they appear adds an important visual characteristic to the mix. Remember, anything that is not plain text tends to draw the viewer's eye to itself. It is common sense to make the most of that opportunity.

3. To make production easier. The more diagrams there are, the greater is the likelihood that this variety will be hard to control. They will probably vary in subject, treatment, draftsmanship, and style—and for the usual mundane reasons: not enough time to remake, many different sources of supply, a group of individualists creating their own personal interpretations—you probably have to live with the heterogeneous mixture you get. On the other hand, a visually consistent set of boxes into which they can all be slipped allows you to camouflage inconsistencies. You can get away with the variety forced upon you by packing it inside the boxes while gaining your desired unity of impression by the regularity that the boxes themselves yield.

The best box or frame is one that is consistent in its detail (in terms of the line work itself), but that can vary in size to accommodate whatever needs to be enclosed in it. It may be possible, too, to predetermine horizontal widths that are coordinated with the columns on the page, allowing the heights of the rectangles to vary at will. You can even carry that a step farther and determine the height of the boxes in increments of typeset lines, so that text and diagrams fit as snugly as pieces of a jigsaw puzzle.

When you think of frames, consider the possibility of building into them some solutions to recurring problems you face in each diagram presentation—they usually have titles of some sort; they cite sources for statistics; they tend to be given numbers (for example, Figure 1, Fig. 2, IIA-13.56); they often show graphic scales when depicting measurable images; they usually have legends, keys, and compass roses if they are maps. It might be possible to incorporate these repeating elements cleverly into the framework. Or perhaps each frame could specify in advance the placement of such elements, so that not only the frame itself but the handling of the text becomes visually patterned, consistent, and recognizable.

On the following pages you will see a collection of boxes and frames. They have been assembled with one purpose in mind: to act as idea starters, so you can make up a shape that will fit your particular purposes—by all means "borrow" any of the examples you see. There is, alas, no such thing as a "correct" format; your interpretation of the needs and the desired image of the publication, document, or presentation will determine the choice you make. Analyze your own requirements dispassionately and develop an answer that is as logical and simple, and therefore as elegant, as possible. Obviously, your personal taste will filter the choices, but you must not allow subjective aesthetics to dictate your tactical decisions. Think of the context in which the diagrams will be seen as an overall object; consider the cumulative effect of an image when it is multiplied over and over: Will it be too much of a good thing? Will it be blowsy and flamboyant or too demure and weak? Only you can make the determination.

Then, before making the final decision, consider yet one more factor: It is important to anticipate how the design of any individual unit will work when you are

faced with the problem of grouping frames. Bunching several units together can be useful in two ways.

1. It can camouflage the fact that you have a plethora of small odds-and-ends by drawing the viewer's attention to the group as a *group*, which "reads" as one. Grouping small units together could be useful when you are trying to play down the technical details of a subject and play up its accessibility.

2. It can also emphasize the wealth of details you have to present by making one big, impressive, attention-getting object of them—an instance of making the most out of rather little.

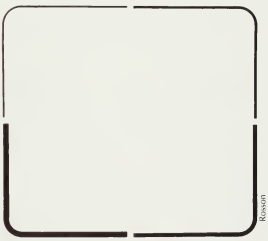
You achieve these varied results by the way you handle graphic expression and the way you permit it to be perceived in its context. Another collection of ideas near the end of this chapter illustrates this point.

A postscript to this introduction to grouping frames is in order, and its substance echoes an earlier statement about flow diagrams: Whenever visual elements are arranged in such a way that they are contiguous, the viewer will interpret sequences and relationships. We automatically assume flows from left to right, top to bottom, and diagonally from top left to lower right. If you want to avoid such misinterpretation, try not to place your diagrams too close to each other or to align them. Rather, scatter them at random. However, if you do want to make use of this tendency to interpret sequence or relationship, do so strongly and unequivocally: Align them, butt them, overlap them, so that their relationship becomes obvious and deliberate. The sequence of such overlapping can go in any direction, but the unit that is most visible (i.e., least "hidden") will probably be seen as the start of the sequence.

Daugherty

Frames aren't really "frames" unless they are graphically more interesting than mere "boxes." Boxes are those obvious, elementary devices made up of simple ruled lines. To illustrate the difference between rule weights, or thicknesses, each of the boxes at left uses four rules of different weights. As composite figures they certainly look peculiar, but if you mask all corners except the one that looks right to you, you can gauge how your final result might look.

The boxes with rounded corners at right are made up of standard graphic materials obtainable as rub-off or pressure-sensitive material at any art supply store. In fact, all the boxes on this and the following pages have been made up that way. Notice how the radius of the rounded corners affects the feeling of enclosure in each box: The wider the radius, the more expansive and welcoming the resultant figure appears.



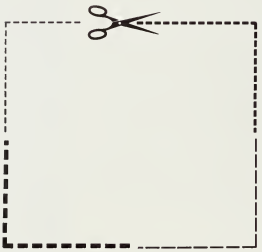
Rosson

Pasulka

Sears

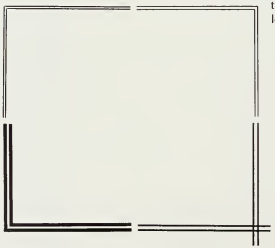
A variety of boxes can be made using graphic materials just as standard as plain rules. The ones at left use four versions of dots ("leaders"), four kinds of dashes ("coupon rules"), four sets of double lines ("parallel rules"), and four sets of rules of varied widths ("oxford rules" for the simple ones, "multiple rules" for the compound ones).

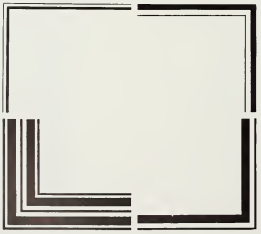
Unfortunately, dashed lines have been preempted in our visual vocabulary to signal coupons-to-be-cut-out, especially if there's a pair of scissors attached to them some way. What a pity that we cannot risk using them otherwise, since they can be very decorative.

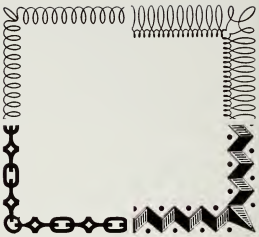


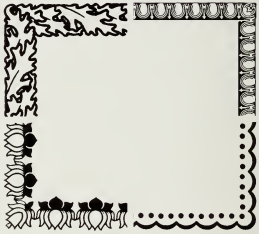
At right we have a collection of arbitrarily chosen odds and ends, of which there is an immense variety to choose from, as each manufacturer vies with the others to bring out useful and original patterns.

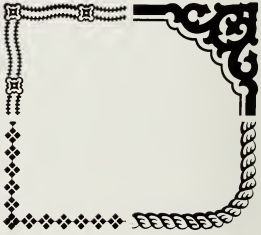
The patterns you see here were drawn at the same size at which they were reproduced in order to help you visualize the dimensions of the raw materials being used. The drawings on the preceding page, too, were done at "full size" or "same size" (SS, or 100 percent, in graphic jargon). Most of the other diagrams in this book were prepared at larger size — in fact at 150 percent or "one and a half times up" — because it is always better to reduce artwork photographically to fit. The draftsmanship looks crisper, the lines lighter, the corners more precise, and the mistakes less visible.

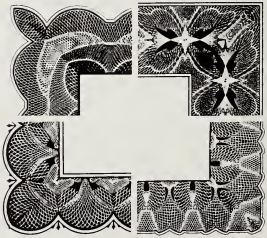


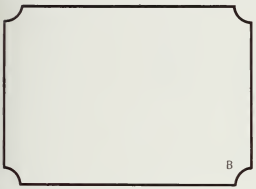


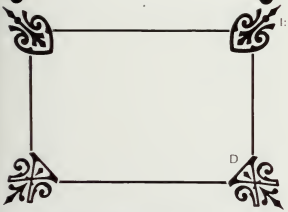


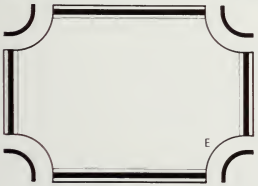












If you seek to distinguish your boxes without resorting to the peculiar line work of the preceding page, why not tamper with the corners instead? All the line work on this page is unaffected straight line, yet all the boxes have different character.

A: Corners lopped off at a 45° angle.

B: Corners turned inward with quarter-rounds.

C: Corners emphasized with dots.*

D: This illustrates the richness of atmospheric effects you can achieve by using evocative graphic materials, such as this very Victorian "carpenter's gothic" corner decoration.

E: In this example the corners are simpler than the line work.

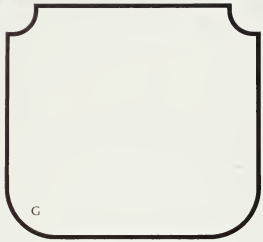
Another direction you can take is to combine two different corner treatments within one frame:

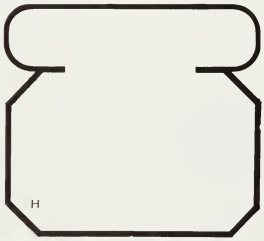
F: Square and rounded corners can be used together at opposite (or contiguous) corners of the figure.

G: You can use rounded corners of two sizes, two facing inward and two facing outward.

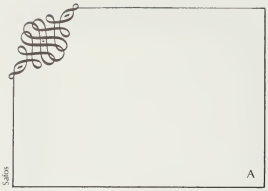
H: Angled and rounded corners are combined here to produce a double box. This figure could obviously be simplified by leaving out the waist-cinching segment in the middle. It is included as a reminder that the dual-corner treatment is ideally suited to partial splitting of the image and is especially useful for separating the title area from the body of the chart beneath.

I: Square and rounded corners are combined here within the thickness of the frame's line itself.





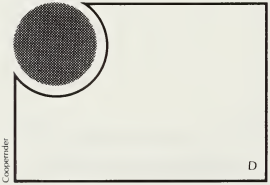
*All corners are hard to produce neatly, no matter whether you draw them, assemble them from adhesive acetate art, rub them off transfer sheets, or even work on electronic screens. The workmanship must be precise and accurate. That's what makes this figure such a dream: The lines don't need to bump into each other. For more on how to do corners, see *Mastering Graphics*, by Jan V. White (New York: R. R. Bowker, 1983), pp. 143 and 152.



Sabin

Vallejano

Zubeck



Cooperrider

Guerrero

The top left corner is the "entrance" to the diagram because it is the first area the viewer tends to study. It is therefore the most appropriate place for some embellishment, especially if such a decorative touch can be made to pull attention to the title or identifying figure number. Similar treatment can, of course, be given to any other corner in order to give the diagram a little fillip, should the top left corner be needed for clear space for the title.

A: Just a squiggle may do the job.

B: For emphasis you can use bold lines; the number that identifies the diagram can be inside the triangle. Most of the angles shown here are 45°, but you can pick your own, of course.

C: This version of B is subtler, since it adds the illusion of a sliver of space that has been created by cutting and separating the card's two parts.

D: The tinted circle, held in place by the encircling curve, could be used for a label or other identification.

E: The simplest solution of all is to use a contrasting color area in the top left corner.

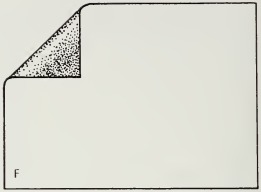
F: The corner has been "curled over" in this example.

G: This dog-eared corner casts a shadow. To make this illusion believable, be sure to make the triangle that is "folded over" identical to the shape of the triangular space left empty by the process of "folding."

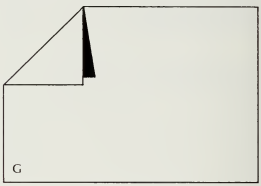
H: A gentler folding angle (30°) is used here. The beauty of this little trick is that you can imply depth and layering as the black corner in the background does. Notice that the corner of the "folded" part is a right angle — a precise 90° — to make the illusion look right.

I: A stylized effect can be achieved by using a background tint against which the white "paper" appears to be floating.

J: The illusion of paper curled over is very difficult to achieve, for it must be drawn realistically. Take a piece of paper, curl the corner and study it. Where are the lines curved and where are they straight? The line of the fold itself must be straight but its ends must curve imperceptibly into the straight edges of the flat paper.

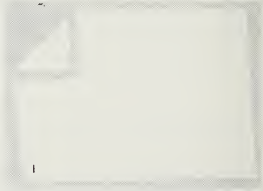


Rosson

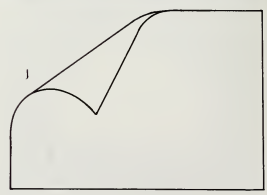


Chrissnut

Mannelli



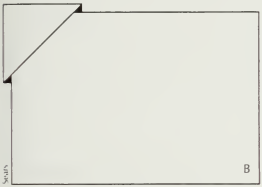
Liebermann



Schaefer

Stoddard

Illusions on paper. These figures are perceived to be floating above the surface of the paper they are printed on . . . bent or spindled . . . overlapped . . . in sequence coming closer to the viewer . . . incompletely drawn yet apparently whole . . . and so forth. The use of such techniques is not cheating; it simply plays upon human perception and accultured training. We might as well make use of this faculty if it makes sense or if it helps to make our charts and graphs more interesting or understandable.



Sears

A: A "hat" has been added to the top left corner.

B: The same hat can be given thickness by filling in the little triangles outside the margin of the rectangle.

C: A similar hat isn't there at all—except for a thin line across the top and the shadow that it casts on the paper.

D: You can wrap a crisp band around the panel . . .

E: or drape a soft band around it.

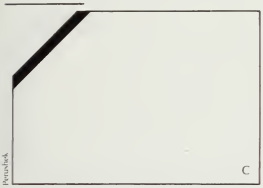
F: By folding a ribbon around the rectangle, the two vertical sides appear to be in front of the two horizontal ones . . .

G: but you could also fold a wider ribbon all around . . .

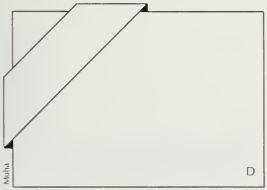
H: or fold a medium-width ribbon forward on the upper horizontal and backward on the lower one.

I: This is an example of ribbon-folding taken to extremes.

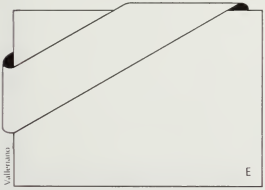
J: What if you add shadows? The object that casts them is separated from the background and therefore appears to be floating in midair between the surface of the paper and the viewer.



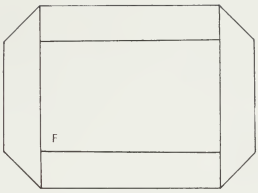
Penschuck



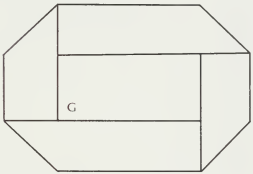
Mehta



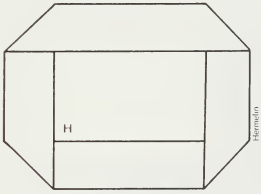
Valberuna



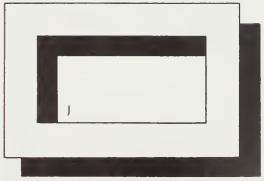
Chovan



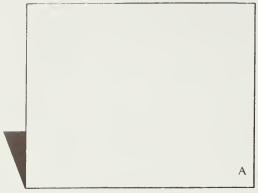
Zell



Hernden



Derr



More illusions. The shadows in the illustrations at left create a variety of perceived effects.

A: The rectangle is standing up like a billboard, casting a shadow on the landscape beyond.

B: The same rectangle appears to be floating above a much larger, spherical object because the edges of the shadow it casts are curved in both directions, whereas its own sides are straight.

C: This rectangle, shown in front of a soft background, is much gentler as an image than the aggressively shadowed frame (J) in the lower right corner of the preceding page.

D: This rectangle, bent upward at the left end, appears to be sitting directly on a surface and lit from the right.

E: The same rectangle is shown here floating above the surface, still lit from the right but here a little higher up.

The shapes in the right-hand column make use of the feeling of enclosure engendered by curves.

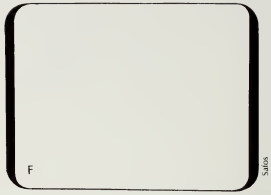
F: Here the decorative quality of contrasting line weights and the smooth transition from light to bold is evident. It adds visual richness to the feeling of being enclosed by brackets.

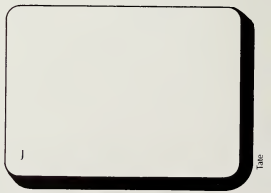
G: A line of equal weight surrounds a central area. The gap at top left is an unexpected element of the design. Yet, in spite of its openness there, the enclosure is interpreted as being complete.

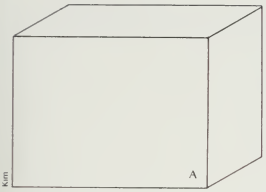
H: The smoothly curved corners, steadily increasing in line weight, and angled ends contribute to creating a dynamic feeling of activity. But, as in the example above, the incomplete frame is interpreted as being fully enclosing.

I: The continuation of lines to enclose the central area is visualized in the viewer's imagination.

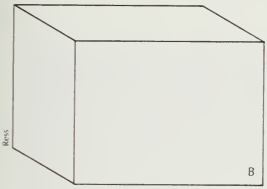
J: How about adding the illusion of the third dimension?



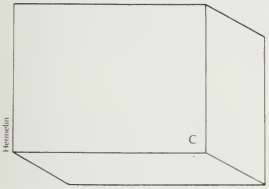




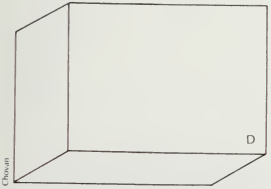
Kim



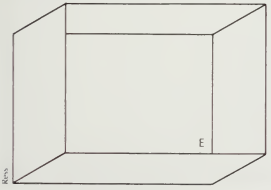
Ress



Hermelin



Chisum



Ress

The illusion of a third dimension — depth — is created by tricks of draftsmanship, to be sure. But this is perhaps the most valuable of all such sleights of hand, for it helps to give our statistics body and volume. Not only does that make them more credible (somehow something solid is so much more believable), it also makes the material more accessible. Just as we see the world in full color (and black-and-white photos as mere abstractions), so do we see our world as one that is full of solid objects (and the anemic single-plane diagram is an abstraction visible as such from only one very special point in space: at right angles to the object or in "direct elevation"). Any effort we make to give our statistics fuller shapes will pay off.

Enough has been said about three-dimensionalization in Chapter 3. Let us just examine a collection of backgrounds here (pedestals, bases, panels) on which or within which our statistics might be displayed.

A: The container seen as a solid from above right . . .
B: and from above left . . .
C: below right . . .
D: and below left.

E: The same object as D, made to look like an empty carton by showing the "inner" lines.

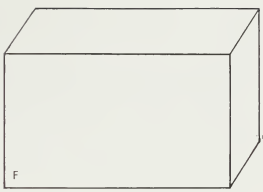
F: The angle chosen for constructing the "side" of the object affects its perceived shape — the five diagrams at left are all based on a 30° angle. This one is drawn at 60° to demonstrate how uncomfortable the image can be made to look if the angle is too steep. It looks as though it might tumble over at the viewer at any moment.

G: The container can be rendered as a series of planes receding in space at a 30° angle.

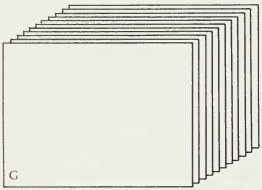
H: This box has been drawn at 45° with a 30 percent screen of black stripped into the horizontal plane and a 60 percent screen into the vertical plane. The side of an object normally appears darker than the top because light shines down from the sky. For added drama, this rule of thumb can be reversed, of course.

I: A carton can be made deliberately tubular by thickening the material of which it is apparently made. That is done by doubling the lines of the frontal plane, as in this example.

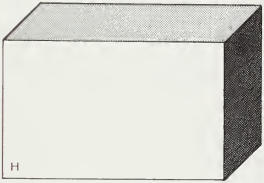
J: A "niche" has been carved in the wall represented by the white paper of the page you are looking at. The illusion of depth is created by the angles and the draftsmanship, as well as the tonalities added to the line drawing to simulate lighting conditions.



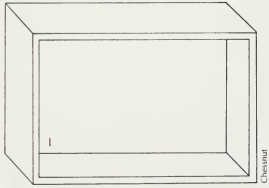
Rosson



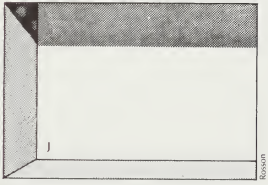
Sears



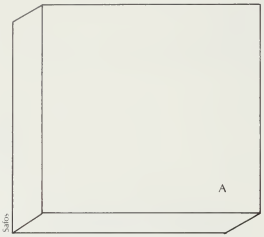
Hermelin



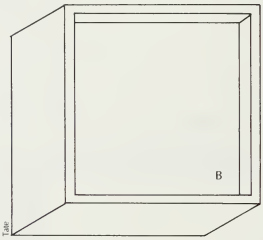
Chesnut



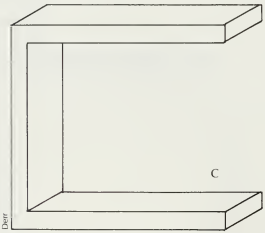
Rosson



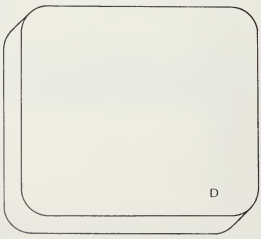
Sahr



Tate



Derr



Zobeck

You have to visualize in your mind's eye what these objects represent. Then they will become realistic backgrounds for the statistics you can combine with them to make the presentation more interesting. There's no magic in it; all that's required is a little imagination.

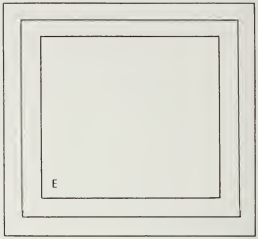
A: A simple, flat box appears to be hung on a wall because you are looking up at it. It could, of course, be standing upright on an invisible sheet of glass that you're peeking through from below, but that is rather unlikely.

B: Yet another box, this time with a more complex front, has been hung on that wall. It is the end of an air-conditioning unit, perhaps? Or a partially pulled-out drawer seen by a mouse from the inside of the chest of drawers? Or is it the flat roof of a square house with parapets around the top seen by a bird flying above? It could become any one of these, depending on what you choose to flesh out the bones of the drawing. It is in the detailing that the image becomes real and understandable: birds in the air for the aerial view of the house —or palm trees perhaps? Droplets of water coming out of the air conditioner?

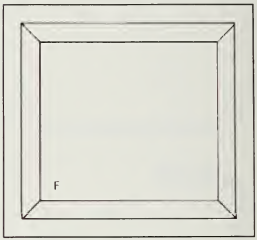
C: Could this open shape be a rectangular horseshoe? A stringless and misshapen harp? A tuning fork as seen by a cockroach?

D: Rounded corners yield a feeling of heavy solidity. They make the object appear as immovable and permanent as antitank emplacements made of concrete, or perhaps cookies that didn't succeed.

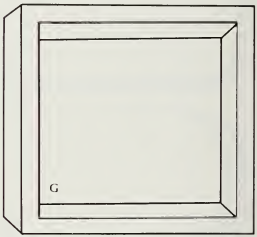
E: Visual imagination can be stretched to such lengths that figures that cannot exist in reality can be drawn to appear perfectly logical. Such "impossible figures" are tricks played upon us by the fact that we trust our eyes and interpret what we see in the light of our experience. H, below, is such a figure. One corner is seen from above, another from below. Is the figure twisted? No, it is plain trickery of draftsmanship and childishly simple to produce. All you need is three lines at equal distances from each other enclosing a space, and a 45° triangle. Start with such a frame, shown in E. By joining the corners (as in F) you create the third dimension. Here you are standing in front of a window, looking straight out through it. You can move to the side a little and be looking at the same window from the side by changing the way you draw the left-hand vertical bar of the frame. G is such a version. The trick comes into its own when you apply the same draftsmanship to the wrong corners of the diagram, as in H.



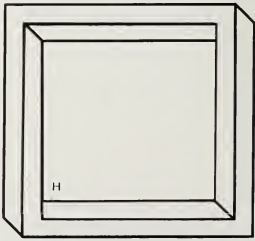
Derr



Muha



Zeil



Zeil

Combining frames and titles

Here are 14 variations on the theme of frames. What each of these examples takes into account is the fact that a frame can be constructed in such a way that recurring elements can be built into the very structure of the frame. Thus, whenever you have to accommodate an element such as the title, you can invent a graphic expression for it that will make it a special feature. Not only will it fit the presentation better, it will also enrich the cumulative impression of all the diagrams. Furthermore, it will make production easier because you won't need to "reinvent the wheel" every time you package a diagram.

A: The simplest possible treatment might be to use changing tone value. The title would be dropped out as white type from the top of the figure where the dark areas occur, and the statistical matter would be surprinted in black type across the lighter area at bottom.

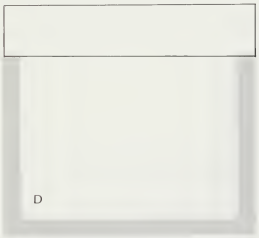
B: The opposite extreme from A would show the background as a self-contained plane; the title would be printed on it, and the graph is drawn onto a separate plane that appears to hover in front of the backdrop.

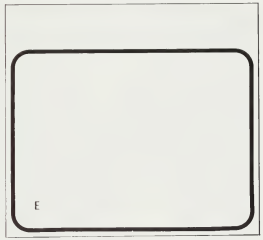
C: In this aggressive solution, the title drops out from the bar across the top.

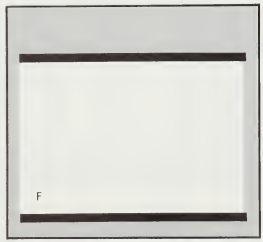
D: This solution is similar to C but somewhat gentler on the eye. It is also more expensive because it involves stripping in tints.

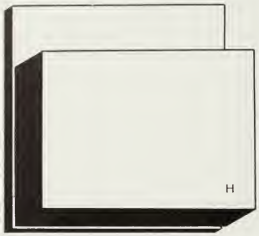
E: Using an outer frame to define the overall shape of the diagram may be useful when there are a lot of diagrams to be accommodated. The inner frame with rounded corners defines the area in which to show the statistics. Obviously, the corners don't have to be rounded, but the diagram as a whole seems more decorative that way. The title goes in the wide space between the rectangles at the top.

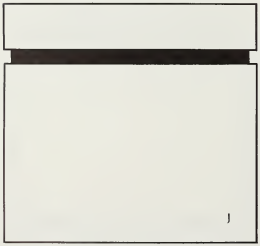
F: Similar to E but softer due to the use of gray (a friendly color), this diagram frame gains the needed touch of sparkle as well as authority through the use of bold rules.











G: Here the two elements seen in E have been separated from each other into two overlapping planes. The one in the background is rendered solid black just to show that it could be done, though it could just as easily have remained white. The result would not be as startling an image, however.

H: Another version shows the same planes separated, this time drawn at 30° in false perspective. It can be rendered simply as a box atop a box.

I: The title and body of the diagram have been separated into two units.

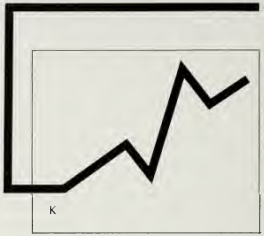
J: A rectangular version of the separation shown in I, with the functions distinguished from each other by tints. The black bar that appears to lie "behind" the two panels in the foreground glues the two parts together.

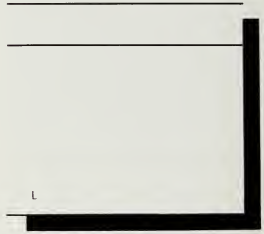
K: A little lighthearted hocus-pocus is at play here. The graph's curve pokes out and runs up the side and across the top of the diagram to enclose a space above it into which the title can be dropped.

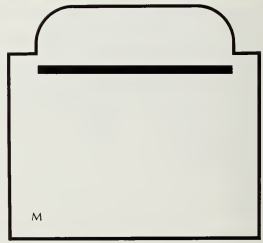
L: More illusionism. Shadows make us believe we are seeing things that aren't really there. This time the vertical lines are missing, but we don't miss them — in fact, they appear to be there.

M: An example of making the illustration reminiscent of something else is shown here. The shape is that of an art deco object of the 1930s.

N: This diagram makes it appear as though a white file card with rounded corners were lying on a gray tabletop.





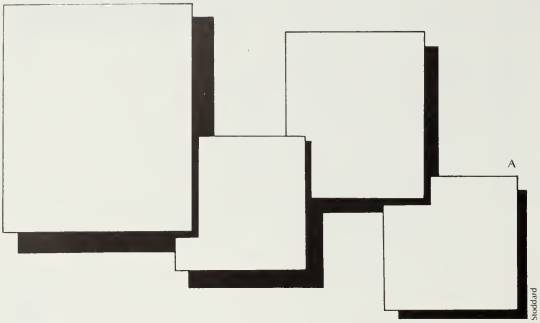


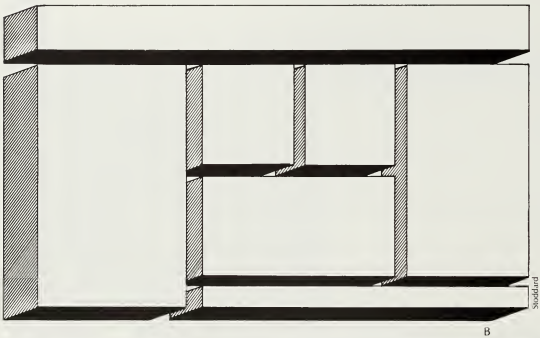
Grouping frames

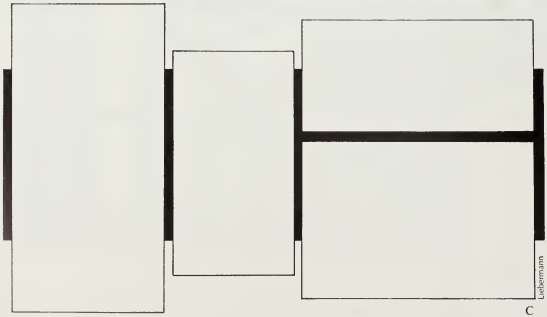
Assembling frames into a group does more than combine several disparate units into one mass. It also establishes a relationship among the parts and their individual meanings. Grouping is not just a graphic ploy but an editorial one as well.

The patterns here and on the next pages are intended as thought provokers. None of them requires skills any greater than those needed to make the individual frames shown on the preceding pages. None is particularly difficult to construct, although some are clearly trickier than others. The clustering does take time and effort to work out and therefore it costs money. But the investment pays off handsomely by giving the result the dignity of large-scale visibility that a random cluster of individually presented units could not hope for.

From an editorial standpoint, pictorial backgrounds are most effective, for the image is loaded with meaning and describes the subject matter as well as the purpose of the diagram. It is possible to combine a diagram with a picture by dropping out line work from the halftone background as long as the area is dark enough for the needed contrast. You can also insert the diagram as a rectangle that overlaps the picture's edge, or you can encase it inside the picture altogether. Such configurations are often called "mortises" by the printing industry. For more amusing results, allow an element of the picture (such as the telephone here) to overlap the diagram.







A: Here overlapping units are enhanced with shadows. Not only do the shadows give the overall group a crisp and attractive sparkle, but they also provide a rationale for the overlapping. It is quite possible for one piece of paper to appear to be tucked beneath another. The dimension of depth is undoubtedly visible, but note that when the shadow falls on the far background, it casts a much wider band of shadow than when it falls on the surface of a rectangle floating above that background. It is the contrast of those widths that creates the illusion of stepped planes receding in space.

B: These three-dimensional boxes are viewed from below left. The spaces between the boxes are kept deliberately even. The bottoms of the boxes are blacked in, the sides are gray. However, any other arrangement would probably be just as acceptable. To see what the view from a different angle would be, turn the page upside down. It works just as well that way.

C: This series of rectangles is held together by a ribbon that appears to hover behind them. The same width of black slivers can be glimpsed between the rectangles, and the slivers have been aligned carefully on top and bottom. The shape of that ribbon is evident enough to allow the superimposed rectangles to be drawn to whatever proportions are needed to contain the statistics.

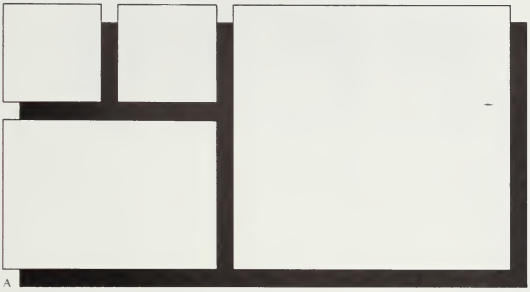
The same basic approach is shown here using three different techniques of rendering. All three depict boxes floating in front of a rectangle that appears in contrasting color and off-kilter —down a bit and to the right or left.

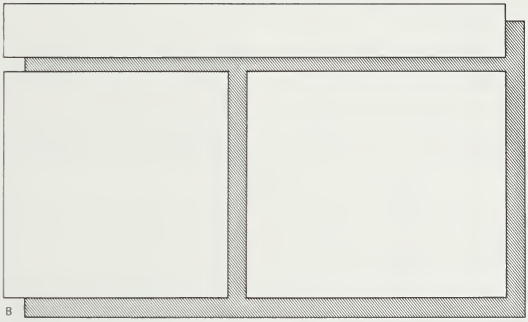
The kind of graphic enrichment you choose to apply affects the atmosphere of a diagram significantly. However, the interpretation of that atmosphere depends on a number of factors: the context in which the diagrams appear, materials used to render the diagrams, the subject being reported on, the expectation the producer and recipient of the diagrams bring to the interpretation, and personal, subjective preference. It is virtually impossible to generalize about any of those things; it is possible, however, to show options and hope that each diagram maker will pick those techniques that make the best sense for his or her specific needs.

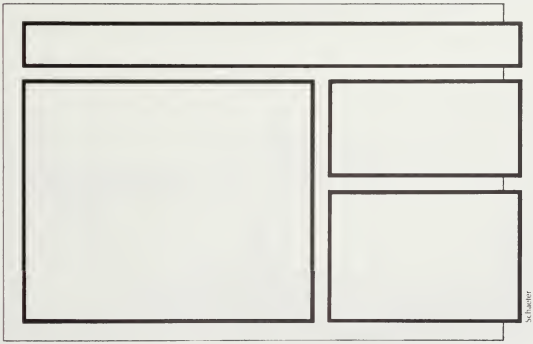
A: Here white rectangles are shown on a black ground.

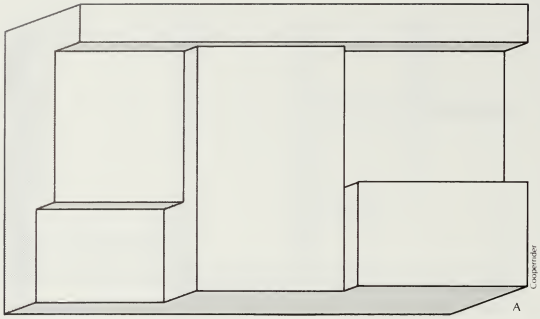
B: A variation on the theme: white rectangles on gray . . .

C: or, alternatively, white rectangles defined by bold outlines against a white background defined by light lines.

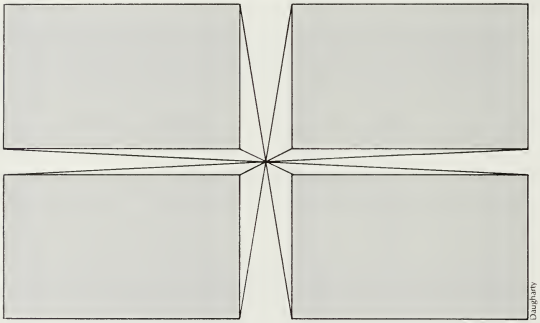




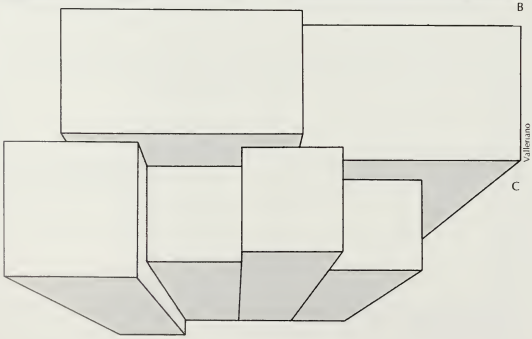




A



B



C

If you imagine your rectangles to be the *ends* of rectangular bars rather than flat planes floating in space, you open up a whole new sense of purpose for which to assemble them.

A: This is a hybrid solution, bridging the technique shown on the previous page and the dimensional technique shown below. The wildly floating objects in B and C are anchored to a wall-like corbels. The statistics will be pasted up onto the spaces like posters on a wall, and the title will run in the valance across the top. Constructing this apparently complex figure is not at all difficult. You start at the flat end (at the left) and literally "build" the rectangles from left to right and toward you. The whole block is a logical progression of spaces and planes, all connected with "sides" drawn at one simple angle.

B: Four equal-sized rectangles, seen as the ends of rectangular tubes floating in space and disappearing in the distance. The point at which the lines converge is the "vanishing point," and it can be anywhere you want to put it. Here it is placed plumb in the center because it makes an attractive star pattern. But it can be behind one of the rectangles, or above, below, to the side — wherever it pleases you. You have to experiment in order to determine the ideal location. Then you can have fun shading the sides or tops of the "tubes."

C: This diagram uses the same structural approach as the one in A, except it is grafted onto the vanishing point used in the one-point perspective in B. The proportions as well as the size of each rectangle vary, as does their position in space. That can be a useful means of stressing one set of statistics over another: The bigger, closer rectangles obviously demand more attention at first glance, whereas the smaller units that appear farther away are interpreted as supportive, secondary data.

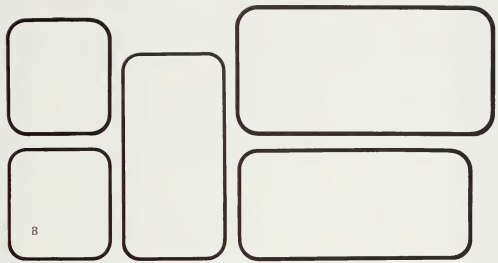
These more basic ways of combining diagrams are perhaps less glamorous than the flamboyant examples on the preceding pages, but they are no less useful. It is possible that their very simplicity makes them even more useful than the complex configurations that require more labor.

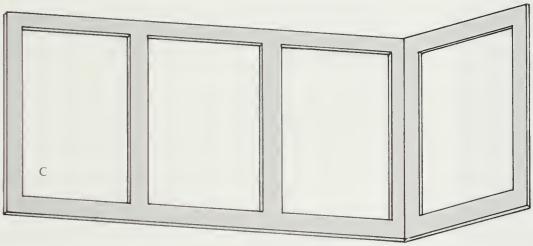
A: Alignment is, of course, a fundamental linking technique. Here it is emphasized by the horizontal indices that run right across the figure in the background. Repetition of shapes of equal size is just as fundamental. Both are used in this example; together they result in a strong image.

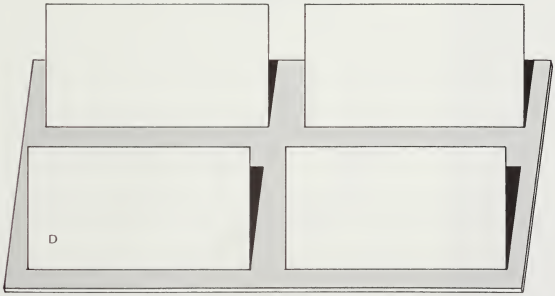
B: Even if the proportions of the individual rectangles vary, the peculiarity of their shape (the rounded corners of equal radius) pulls them together. The spacing between the elements is as important as the shapes themselves. If they are carefully kept at constant width, the spaces will act as a mortar cementing the units into a homogeneous mass.

C: If normal shapes are called for, why not present them at an angle? Even a very shallow angle is an unexpected variation from the norm. That will separate the diagrams from their surroundings and thus give them that desired unity.

D: Instead of tilting the units themselves, as was done in C, the background can be tilted and the units placed on it in the normal, vertical fashion. The vertical rectangles can be made to appear to be casting shadows onto the tilted background. But there we are getting into picture making, realism, illustration. The sky's the limit there.



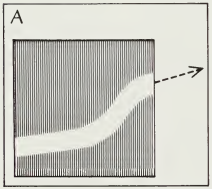




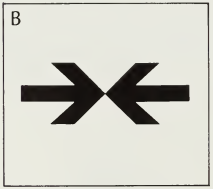
■ In our effort to make images eye-catching and appealing, we are often forced in the wrong direction: dressing up the bare bones of the data with flamboyant color or other cosmetic superficialities. Instead, we should concentrate on exposing the ideas inherent in the statistics by devising forms that express them naturally. The shape should grow organically out of the story.

However, translating factual information into even the most appropriate visual form as diagrams is but the first step in verbal/visual communication. It must be supported by a second step that follows from the first: understanding how the recipient is likely to interpret the diagrams. That, alas, is a consideration that is usually ignored in our thinking about how to translate verbal language into visual form. We must accept the fact that the question of interpretation exists, and, realizing that visual forms inevitably carry shades of meaning, we can make the interpretations themselves an integral part of our communication resources.

The arrow is an excellent example of a symbol whose shape is itself potentially valuable as a bearer of inner meaning. It is a symbol that lends itself to a vast range of interpretations depending on how it is rendered. It does not have to be a cliché. When imbued with broader meaning or shaped to express specific ideas, this otherwise prosaic symbol can turn into a lucid pictogram that tells a story in universal (visual) language. The interpretation of this arrow can run the gamut from a literal description of its form ("an arrow breaking out of its constraining box") to any one of these:

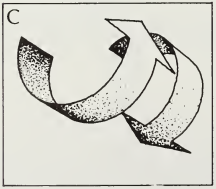


Progress
Overcoming obstacles
Vision of the future
Busting out of prison



These arrows are indeed face to face.
But they may also denote:

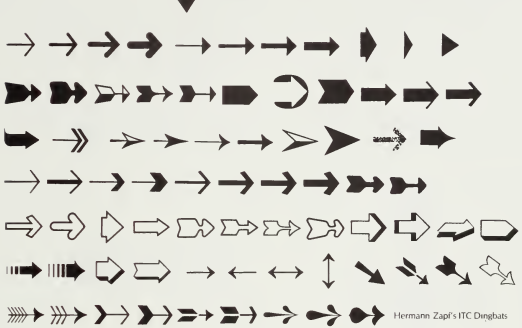
Confrontation
Stalemate
Conflict
Kissing



Those two arrows illustrate concentric twisting, of course.
However, they may also be interpreted as:

Opposition
Working at cross-purposes
Torsion
Getting tanned all over

What follows is a collection of 132 more variations of the arrow, captioned with suggested interpretations. Clearly, this is not a definitive catalog of all configurations that can be devised for this marvelous symbol, nor are the interpretations the only



Hermann Zapf's ITC Dingbats

ones—let alone the "correct" ones. (There's no such thing.) They happen to be the ones that came to mind; they are shown here to provoke further thought. You can construe any meaning that is appropriate to the specific circumstances or context in which the arrows will appear. The context is, of course, a crucial factor affecting any interpretation.

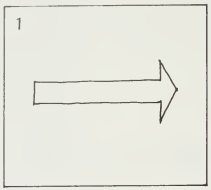
This collection of visual symbols, together with their verbal interpretations, is arranged to allow you to access it in one of two ways:

1. *The graphic way*—by searching for the image that looks right for the point you're trying to make (and arrows make good points!).

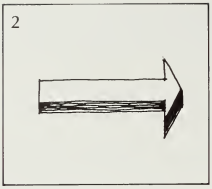
2. *The verbal way*—by looking up the concept for which you need a symbol in the index that follows at the end of the chapter; it will lead you to options for decoding your problem in visual terms.

Such a dual verbal/visual approach to symbolism and interpretation illustrates only the nub of an idea. Imagine the riches of communication techniques that would become available were you to extend this principle to the mass of other graphic symbols that surround us and that we take for granted the same way we do the arrow. Think of the possibilities of utilizing the image-making capacities of a computer and combining them with the interpretive talent of sensitive, visually/verbally oriented designer/editors.

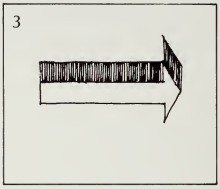
But that is beyond the scope of this book. What we have here is a brief glimpse of the principle itself. It boils down to simple awareness. When you blend that awareness with imagination and add a dash of courage, you have an irresistible combination on which to base exciting communication.



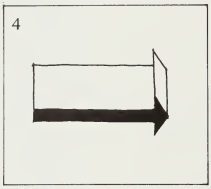
Plain arrow as seen from side.



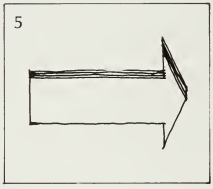
Lower edge darkened to simulate thickness: seeing arrow from above.



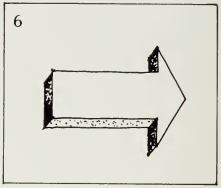
Upper edge thickened and darkened: seeing arrow from below.



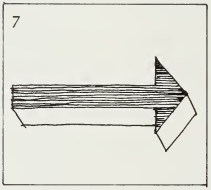
Upper edge exaggerated in thickness, arrow itself darkened for emphasis: illusion of slab shape lying flat.



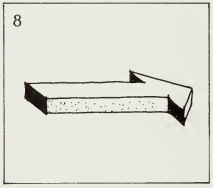
Upper edge thickened just a little, arrow itself drawn wide: illusion of slab shape standing on its edge.



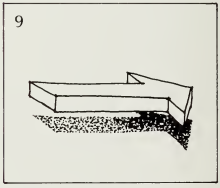
Thickening of edges drawn in perspective: realism.



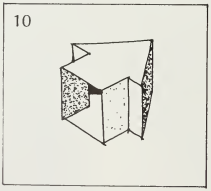
Unexpected angle of perspective and darkening of face (rather than edges): arrow floating above viewer, lit from below.



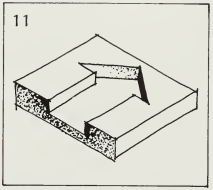
Severe perspective angle: arrow lying flat on a surface.



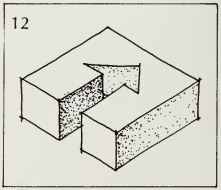
Shape identical to 8, rendered without shading. Shadow cast beneath and partially hidden: illusion of floating above surface.



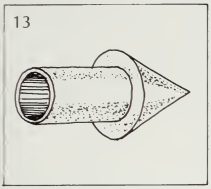
Arrow as a solid hollow object.



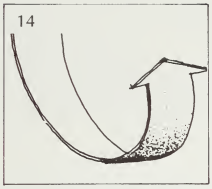
Arrow incised into surface of material.



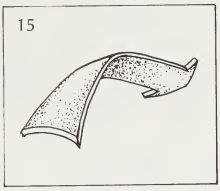
Arrow as negative shape cut from block of solid material.



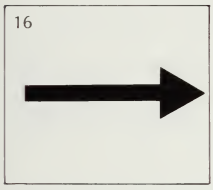
Arrow as a circular (or any other appropriate) shape.



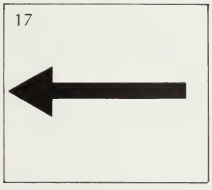
Arrow made of a bendable but flat plane. Improvement. Upswing.



Arrow made of flexible, twisted material. Flexibility. Suppleness.

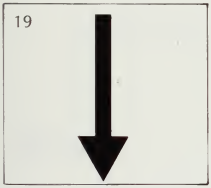


Left to right: forward. Positive. Going with the flow. Good.

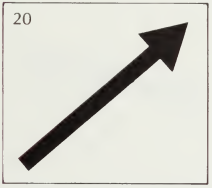


Right to left: backward. Negative. Going against the stream. Bad.

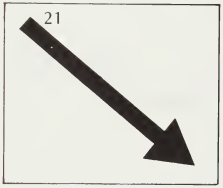
Up. Good. Rising.



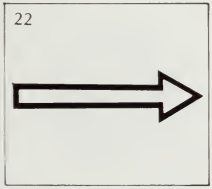
Down. Bad. Falling.



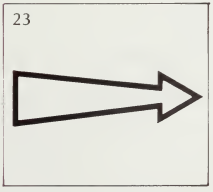
Upward trend, angle determining speed. Ascending. Favorable development.



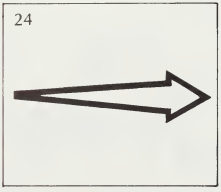
Downward trend, angle determining speed. Descending. Unfavorable development.



Stem of constant thickness. Steadiness.

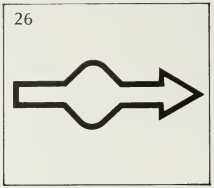


Stem becoming narrower. Decrease at a constant rate. Impairment. Deterioration.

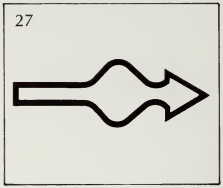


Stem becoming wider. Increase at a steady rate. Improvement.

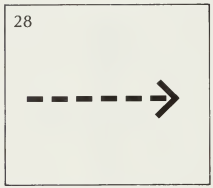
Stem wiggling. Changeable direction. Variability.



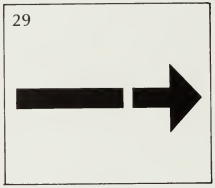
Stem suddenly fattened (or thinned down). Sudden occurrence. Surprise event.



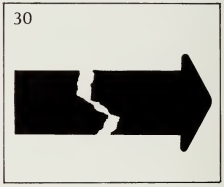
Stem slowly thickens and thins. Development. Phenomenon that takes time to develop and disappear again.



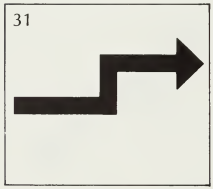
Broken stem. Steady, continuous rhythmic motion.



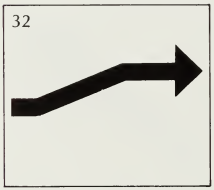
Stem broken cleanly. Interrupted motion.



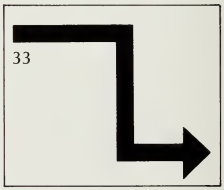
Stem broken in deliberate design. Implies missing a section of the line.



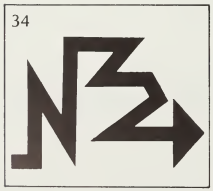
Sudden change of direction. Upward, sudden improvement. Downward, sudden deterioration.



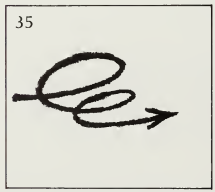
Slow change of direction. Gradual improvement, remaining at that level.



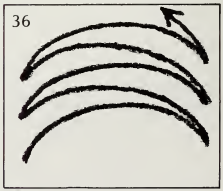
Unexpected disaster.



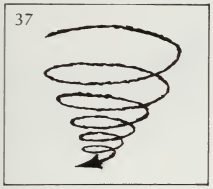
Uncertainty. Indecision. Confusion. Erratic action. Vacillation.



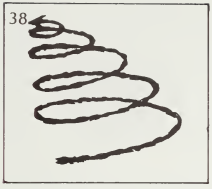
Complexity. Entanglement. Complication. Spinoff.



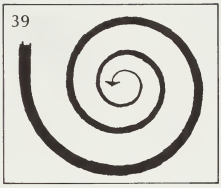
Oscillation. Vacillation. Unpredictability. Deterioration. Retrogression. Relapse.



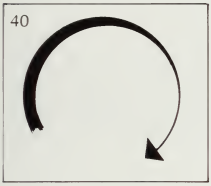
Downward trend. Decline. Slippage.



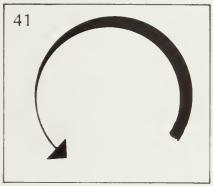
Improvement. Progress. Upward mobility. Recovery. Perseverance.



Decline at a steady rate.

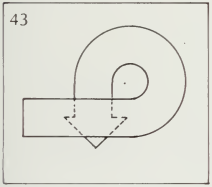


Clockwise. Logical. With flow.

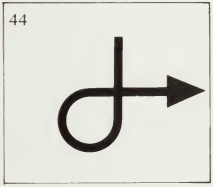


Counterclockwise. Illogical. Against the mainstream.

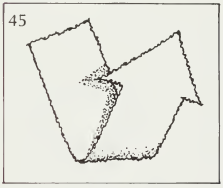
Return to starting point. Recycling. Irresolution.



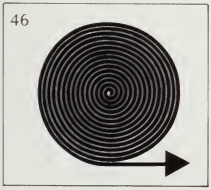
Overlapping. Turning inward. Introspection. Self-examination.



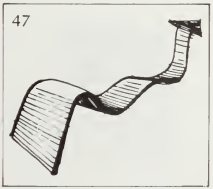
Turnaround. Flopping. Change of mind. Switch in plans. Inconstancy.



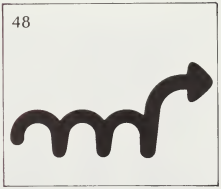
Reversal of direction. Mutability. Reaction. Backlash. Rebound.



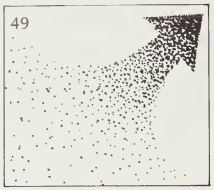
Development. Unrolling. The start of something big.



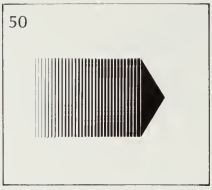
Direction to a distant goal. Flexibility. Development leading to a payoff in spite of obstacles.



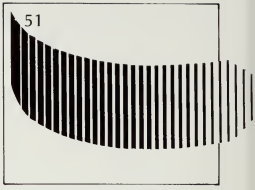
Resilience. Bouncing. Fluctuation.



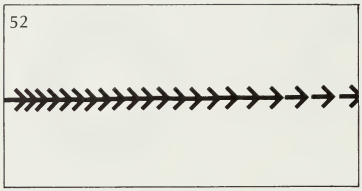
Congealing. Coming together. Creating teamwork. Decision making. Flying away. Consensus.



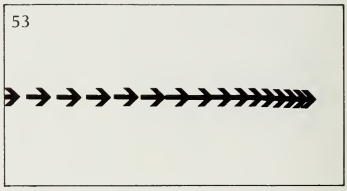
Change of intensity of color. Becoming. Appearing.



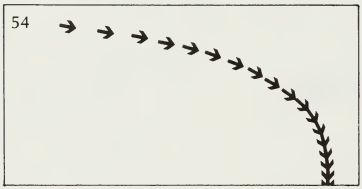
Becoming paler. Becoming less. Disappearing.



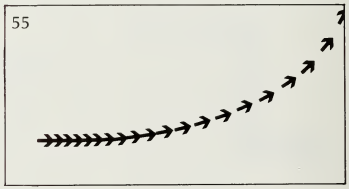
Starting up. Speeding up. Building up momentum.



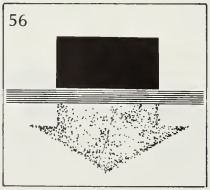
Slowing down. Rhythm. Concentration. Amassing. Stopping. Coming to a head.



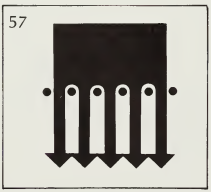
Slowing down over a period of time. Decay. Deterioration.



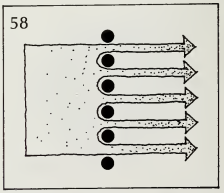
Acceleration.



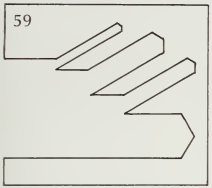
Filtering down. Change. Disintegration.



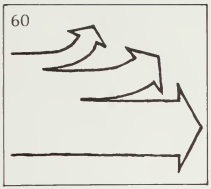
Refinement. Filtering. Straining.



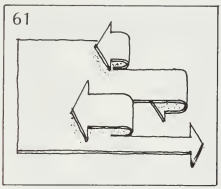
Segmentation. Control. Fragmentation. Screening.



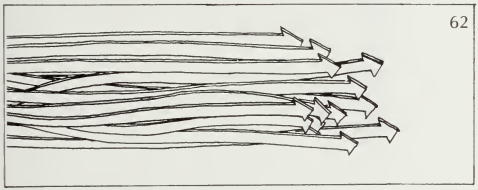
Dispersal. Division into segments of varying importance. Phased action. Divergence. Segmentation.



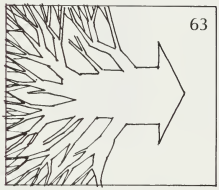
Breakup into unequal parts. Breaking away. Independence. Separation. Decentralization.



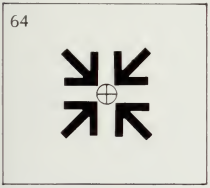
Reversal of some elements. Going against the stream. Changing minds. Vacillation.



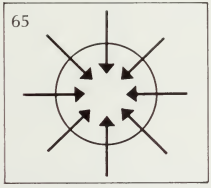
Interaction. Teamwork. Combining forces. Working toward common goals.



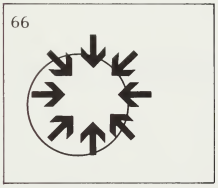
Convergence. Combining. Working toward common goal. Accumulation. E pluribus unum.



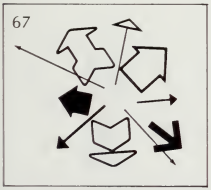
Meeting point. Focus. Centralization. Policy. Pressure. Forces at work. Common goal.



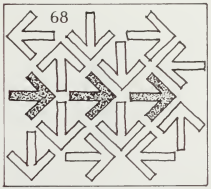
Concentration. Plotting. Convergence. Focusing. Common goal.



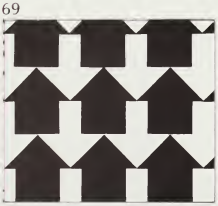
Off-center. Missing the point. Connivance.



Random dispersal. Conflict. Erratic action. Lack of leadership.



Continuing against opposition. Not losing one's way. Charting a path through chaos. Single purpose.

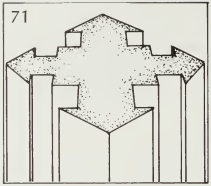


Opposition. Two camps. Working at cross-purposes. Action/counteraction. Reaction. Forces at work.

70

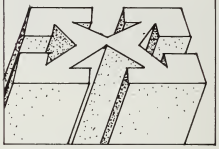
Division. Dispersal in equal values. Internal forces at work. Dissemination. Dismemberment.

71



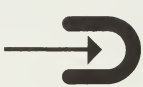
Extroversion. Outgoingness.

72



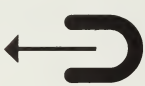
Looking inward. Introversion. Concentration.

73



Going into something.

74

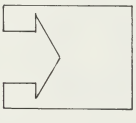


Coming out of something.

75

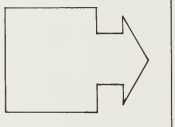
Being trapped. Containment. Storage.

76



Going in. Analysis.

77



Coming out. Resultant.

78

Transferring. Escaping. Change.

79

Adding.

80

Squashing. Overwhelming. Authority. Bossism.

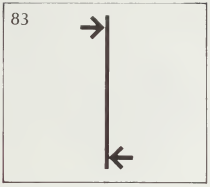
81

Squeezing. Resistance. Equality of forces.

82

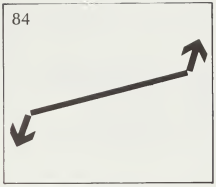
Opening up. Unlocking. Expansion. Freedom. Encouragement.

83



Concentric forces. Tangential forces.

84

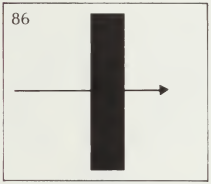


Centrifugal forces. Dispersal.

85

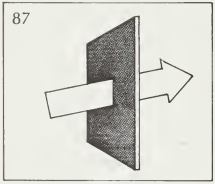
Overcoming. Breaking through.

86



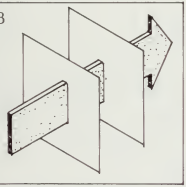
Overcoming heavy opposition. Success.

87



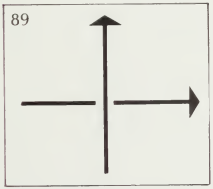
Progress. Overcoming opposition.

88



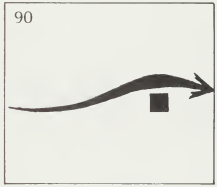
Achievement. Weak opposition. Penetration. Breaking through barriers.

89



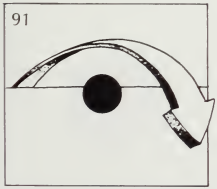
Overpass. One direction stronger than the other.

90



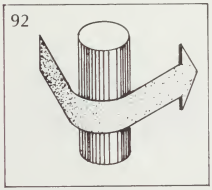
Overcoming obstacle. Recovery. Revival. Bypassing obstacle. Vaulting over problems.

91



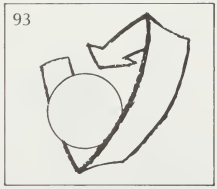
Deflection from course. Unpredictability.

92



Disturbance. Absorption. Fickleness. Magnetism. Deflection from direct route.

93



Production effort caused by element symbolized in center. Influence.

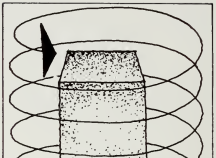
94

Success based on object depicted in center. Crediting leadership. Processing with central purpose.

95

Processing. Influencing. Refinement.

96



Developing a central element by external manipulation.

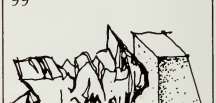
97

Reflection. Deflection. Turnaround. Strength of opposition. Repercussion. Result.

98

Feedback. Reflection. Frustration. Containment of action. Constraint. Being boxed in.

99



Opposition. Resistance. Shattering. Frustration. Obstacle stronger than force intended to overcome it.

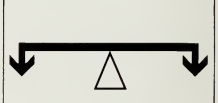
100

Balance. Equal pull. Duality. Dichotomy.

101

Indecision. Elevator operator.

102



Balance. Leveling of forces. Fulcrum. Pivotal decision.

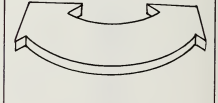
103

Uncertainty. Ambivalence. Duplicity.

104

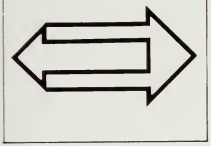
Ambiguity. Ambivalence.

105



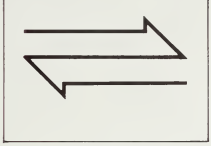
Equality. Compatibility. Two-pronged approach. Two options for moving ahead.

106



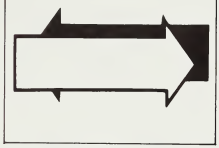
Internal opposition. Irresolution.

107



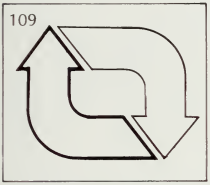
Bypassing of effort. Inefficiency. Inconsistency. Inability to make up one's mind.

108



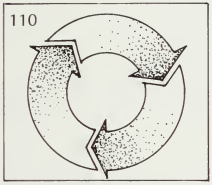
Working at cross-purposes. Action/reaction. Disagreement. Interaction.

109



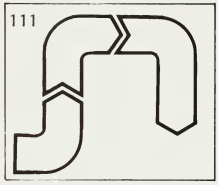
System. Balance. Fulfillment. Efficiency. Comfort.

110



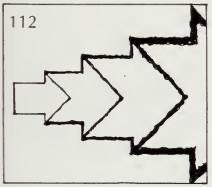
Process. Interaction. Following through. Futility. Chasing your own tail.

111



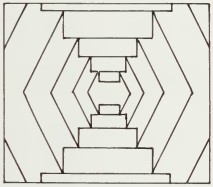
Influence. Consequence. Sequel. Logic. Flow. One thing leads to the next.

112



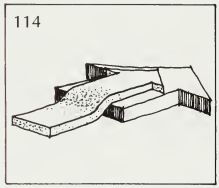
Promotion. Advancement. Enhancement. Sequel. Trailing.

113



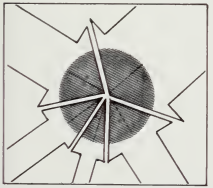
Cause. Result. Growth. Conformity. Reflections. Development.

114



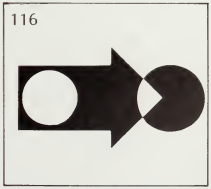
Overlap. Building on previous effort. Flexibility. Resilience.

115



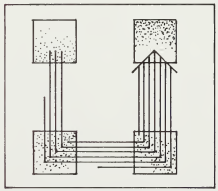
Cause and effect. Targeting. Teamwork toward common goal.

116

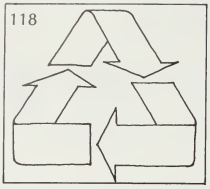


Reaching an objective. Cause and effect. Consequence. Derivative.

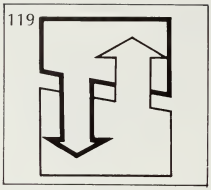
117



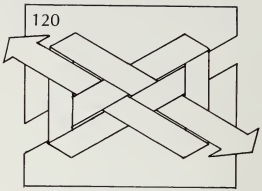
Growth of process. Planning. Strategy. Organization.



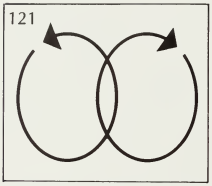
Pursuit. Interrelationship. Flexibility.



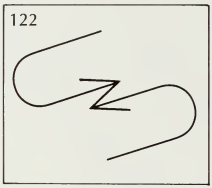
Interpenetration. Ambivalence. Dichotomy. Partnership. Love.



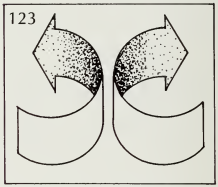
Complexity. Working at cross-purposes. Interdependence.



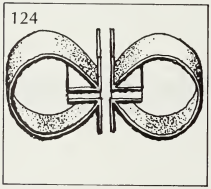
Choice. Division. Uncertainty. Interaction.



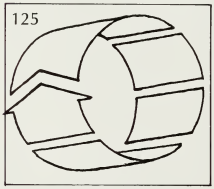
Mixing. Joining. Scheming. Plotting. Mutual effort.



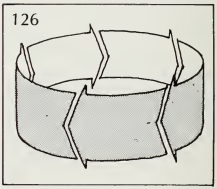
Separation. Divergence. Disagreement.



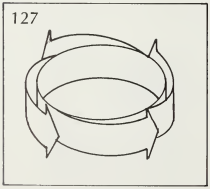
Cooperation.



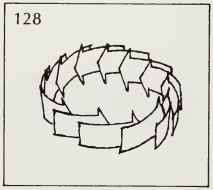
Continuity of process. Irresolution.



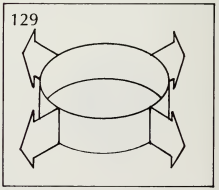
Teamwork. Cooperation.



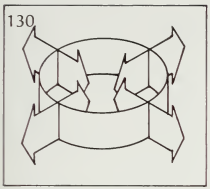
Centrifugal forces. Dispersal. Dissemination. Radiation. Decentralization. Motion.



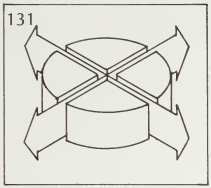
Cooperation. Collaboration. Agreement. Alliance. Convergence. Refinement. Many small steps toward one goal.



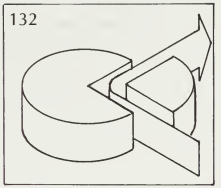
Indecision. Phased process. Implications. Radiation. Projections.



Interpenetration. Influences. Cross-purposes. Breakthrough.

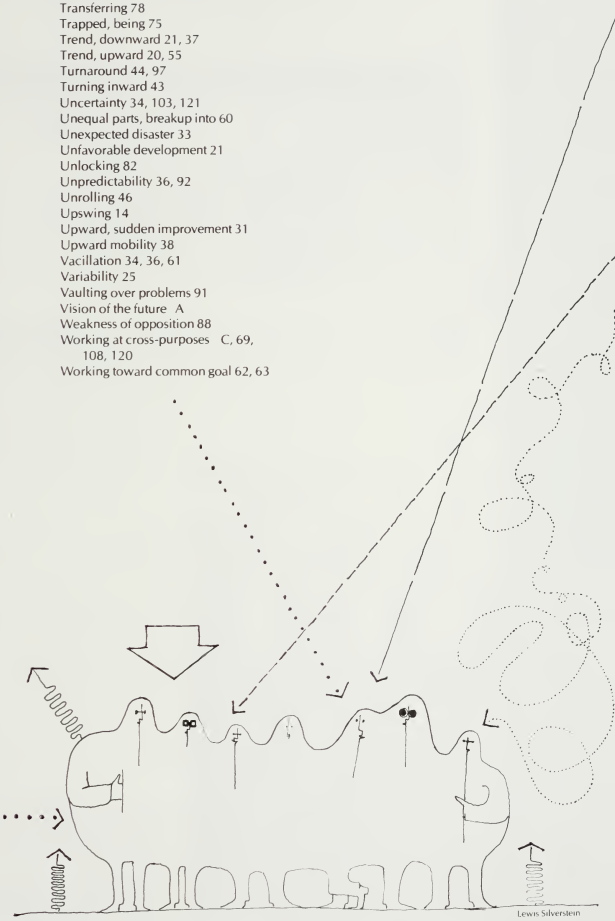


Splitting. Decentralization.



Isolation of one element.

Index to visual interpretations



■ A chart is a statement of facts presented in visual fashion. As such, it is like a sentence that could be read as follows: "If you look at these facts here and correlate them with those over there, you'll quickly discover that . . ."

Each of the many different chart and diagram formats has its characteristic advantages: The pie indicates proportions of a whole; the curve shows change over time; the bar or column chart compares sizes to each other. Choosing the ideal format for the material to be communicated is certainly the most crucial as well as the first step in active verbal/visual communication. However, just as a sentence can only contain a certain number of words, often a single chart can express no more than one sentence's worth of information. The information may be very rich, of course, if the chart is complicated; nevertheless, the chart is a single entity, and, as such, is limited in its communication potential.

Very often your message is complex enough to require several sentences, a full paragraph, to get your point across. You need several sentences that make sense together. Just as you combine words into sentences and then into paragraphs, so can you combine charts into groups. If the formats you pick are blended into coherent image groups, your viewer can gather at first glance how they all relate to each other. As a result, two coordinated sets of conclusions can be drawn from your visual information: The details can be studied in segments, and their significance in relation to the whole can be deduced from the way they appear together.

Clearly, there are no rules to follow, for every set of data requires different handling to express its specific intent and purposes. There are only two essential criteria: one, that you be absolutely clear as to what you are trying to say and what its significance is. (That second clause is by no means secondary; in fact, it is probably the most crucial of all. It affects everything you do and forms the basis for the entire discussion of handling graphics astutely in the latter half of this chapter.) The other criterion is as essential as the first: plain old common sense. The following examples illustrate the variety of combinations that are possible by showing just a small sampling of the most obvious.

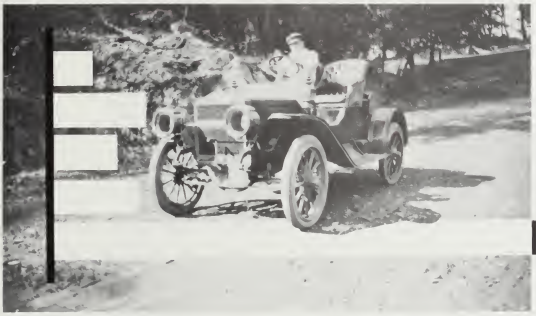
The second half of this chapter shows a collection of examples where the capacity of graphics is shown at work in artful ways to catapult ideas off the page into the viewer's consciousness vividly and effectively. Of course, this entire book deals with that same subject; it is its very purpose. What makes the latter half of this chapter different is that it consists of a collection of graphic tricks—sleight of hand—of whose existence every diagram maker should be aware, even if they are not applied on any but the rarest of occasions. They are exaggerations and twist the expected norms to their own ends. They play upon the viewer's subconscious interpretations in the same way that magicians perform their feats of legerdemain. If nothing else, they illustrate the more esoteric wonders of the graphic language we all have in common.

Combining charts with pictures

Using pictures as backgrounds is perhaps the easiest way to add a dimension of understanding and meaning to a chart. It does not matter what kind of chart you may want to use. A relationship between it and the illustration can be worked out. The graphics are easy. It's the thinking that's difficult.

Since the relationships in chart-and-picture combinations are so dependent on the specifics of each image and chart format, it is impossible to show illustrations of any specific technique as a pattern. The options and the materials are so rich in possibilities that there is no such thing as a pattern to follow. There can only be the

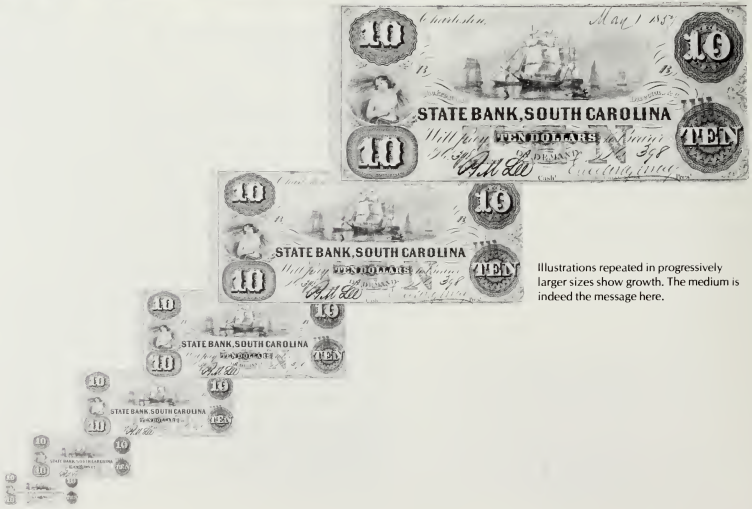
fundamental technique itself suggested in a series of typical thought-provoking examples. Let them act as stimulus to using your creative imagination to intrigue, inform, and influence your audience.



Horizontal bars dropped out from the picture visibly integrate the data into the image. The bar extending beyond the confines of the illustration into the surrounding space strikes the beholder's eye first, and is therefore interpreted as being the most important statistical factor to be understood. The picture explains the context or location in which the statistics occur.

A curve has been superimposed on a photographic background. By letting the apex as well as the final segment of the curve extend beyond the halftone's edges into the surrounding space, the viewer's attention is attracted to those two important points. Furthermore, the surrounding space becomes knitted into the image; the picture and the space that frames it act in concert, appearing the larger and more imposing for the synergy.

The picture has been cut out to follow the shape and progression of a step chart. The fact that the steps are not very clearly visible is a deliberate ploy to illustrate the essential point of graphic appropriateness: You cannot do whatever you want to do with just any picture and hope it will make your point. A stepped silhouette, such as the one desired here, needs to be cut out of a simple, smooth, dark, unified image to make the steps clearly discernible. It has been cut out from a busy image here — and the busyness acts the way camouflage is supposed to act — it breaks up the outline of an image and makes it UNrecognizable!



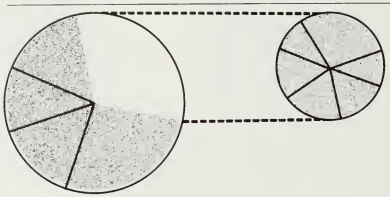
Illustrations repeated in progressively larger sizes show growth. The medium is indeed the message here.

Each of the pie charts inserted into an illustration refers to some aspect of the drawing's subject matter.

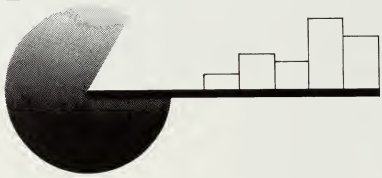
Illustrations can be tied to statistics in any number of ways. The image usually suggests the best way, if you are looking at your illustration in search of it. Here the picture forms the baseline of the column chart (or rather hides a part of it) and thereby suggests an intimate relationship between the subject and the statistics. Such interplay of image and chart gives life and significance to otherwise ordinary data.

Combining charts with charts

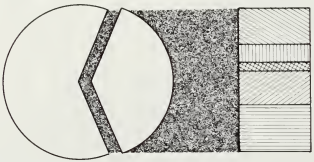
Charts can be combined in such a way that the advantages of each form are utilized to the fullest. Through such combinations, you can make one plus one equal more than the expected two. If you do it with a little flair, then it becomes even more than just two and a half—perhaps three, or even four, if you are very astute and the shapes work! Here are examples to whet your appetite.



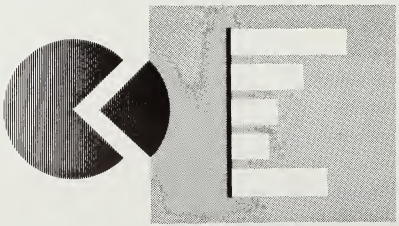
Pie with pie. The large pie shows the total subdivided into its segments; the smaller one shows subdivisions of one segment. This clever way of solving the problem allows you to avoid extra-thin slivers into which you would have to shoehorn all your data. It is much better to break them out this way and make all your information legible.



Pie with columns. This combination illustrates another approach to showing two sets of data. The whole is represented by the pie, while one of the segments—the wedge that is missing—is formatted as a column chart.

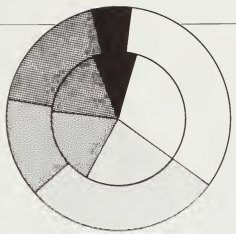


Pie with column. A third example shows yet another way of comparing one wedge with the pie from which it is taken. If the elements of the wedge are more complex or numerous than the five shown here, then perhaps the following technique might be more evocative.



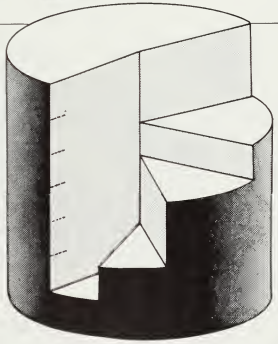
Pie with bars. This is graphically the clearest presentation. The wedge, pulled away from its surrounding pie, overlaps the tint block within which the bars are depicted. The proportions of such bridging must be carefully worked out so that the relationships are clear at first glance.

Pie inside pie. The inner, smaller circle shows the original segments of the whole; the outer, larger circle shows the proportions these segments have reached after some time, for the larger pie is understood to symbolize growth in the overall size. Use of color is essential to indicate the relationships clearly.

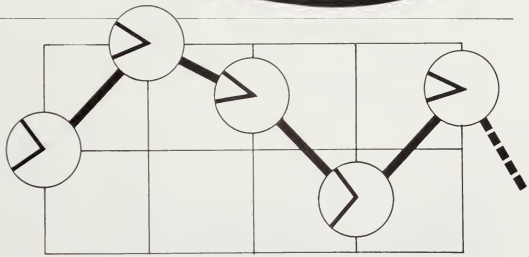


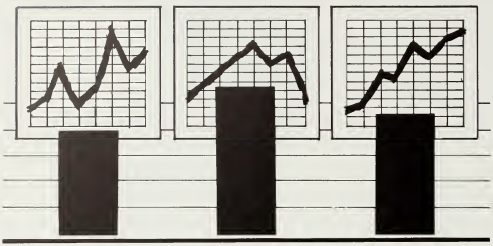
Pie as picture. A three-dimensionalized pie (which looks a bit like a wheel of cheese) can also be separated into its component wedges and depicted as naturalistic objects in space.

Pie as column in three dimensions. One aspect of the information is represented by the height of the cylinder and its scale. The other aspect, the proportion of parts to the whole, is shown by the pie-shaped wedges. The height of the wedges ties that information to the cylinder's height; the size of each wedge shows proportion to the total.



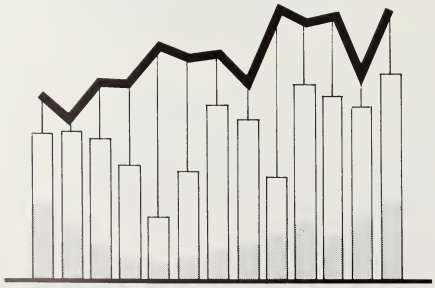
Pies with curve. The relationships between the pies are shown by the curve and details of each change of direction are signaled by pies placed at the nodes. The image implies that the details reported in each pie are responsible for the subsequent direction of the curve's motion.





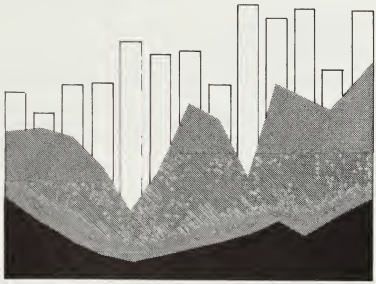
Columns with curves. Each column represents a particular set of data; the presentation of three in such regular proximity implies a relationship between them that refers to the subject of the charts. The corresponding curves attached to each column trace each column's rate of change within the given time frame.

Curve with columns. Each column reports data for a discrete time period; the curve superimposed on the row of columns traces the cumulative history. The first column's top coincides with the "total," for that is the start of the cumulative calculation. The second column shows a "loss," for it is below the zero line. The difference between the first column and the new column is subtracted and shown by the position of the second dot. The third column demands that the third dot be placed lower still —by the amount that the third column has descended further. The fourth column is still a negative value, but much less so; hence, the curve is plotted at a shallower angle, for the amount of the fourth column's "loss" must be added to the cumulative total. The advances over the next set of columns are added to the curve as each occurs. The dots merely dramatize the cumulative changes and are visual embellishments to the simple curve.



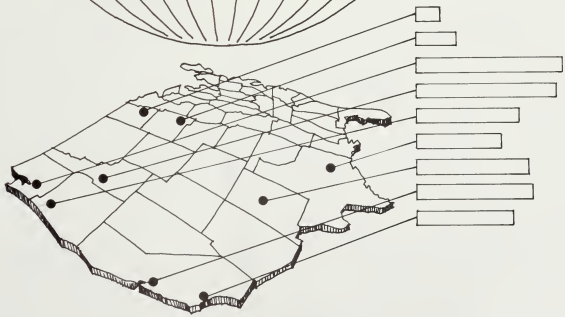
Curve with columns. The curve shows fluctuations of the total for each time period and is clearly the dominant element. The columns below express secondary information and show the proportions of the segments to the total. Since the curve floats so far above the tops of the columns, vertical rules are needed to guide the eye from curve to columns at the point of their relationships.

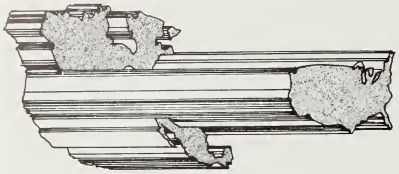
Surface with columns. Similar in intent to the previous example, this rendition reverses the graphic handling, so that the "important" material appears in the foreground surface charts, while "secondary" information hides demurely behind them, appearing as columns that peak behind the mountains.



Globe with columns. The lines of longitude define the size and shape of the columns; the vertical scale, however, is not coordinated to the lines of latitude. This is clearly not an accurate depiction of the globe; instead, it is a stylized *idea* of a globe. The purpose of the diagram is to show production of a given commodity so the rendering of the map can be inaccurate. No one will look upon it as anything but a background symbol for the context in which the data are to be viewed.

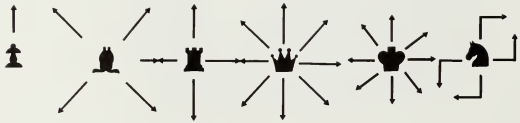
Map with bars. The map functions as locator for various statistical points that have been broken out. Since it is not a mere background mood creator but an active participant in communicating the purpose of the diagram, its accuracy must be retained. The data, charted here as bars but which could be pies or any other graphic expression of numbers, are keyed to the map as callouts.



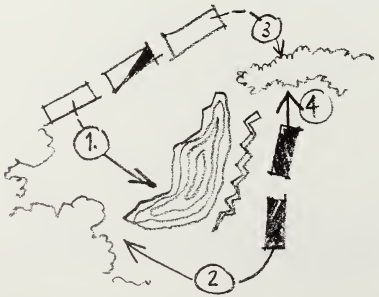


Maps as bars. The three subject areas (Canada, United States, Mexico) are defined by their maps; the comparative statistics relating to each are indicated by the length of the bars.

Circles with arrows. The concentric circles form a background against which the arrows are seen; the values represented by the arrows can be read off the scale created by the concentric circles. The interpretation of an abstract figure such as this must be defined by accompanying words.



Arrows as map. In this game diagram arrows are merged with symbols representing game pieces. The arrows, of course, show the direction in which motion takes place on the board.



Arrows as map in sequence. Since game or battle diagrams often need to show the sequence in which the various steps are to take place, the ruse of numbering the arrows adds a dimension of information to a very simple diagram format.

We expect things to be the way they are *supposed to be* because that's the way they *appear*. We are used to seeing them a certain way and have learned to interpret them accordingly from experience. However, the "normal" appearance of artificial objects such as charts, for instance, isn't nearly as normal as the appearance of objects in nature. Unlike a tree or a sunset, charts are of human manufacture; they are an intellectual artifact whose shape and interpretation are not permanent but can be altered at will. There is nothing "normal" about them. Granted, they may look ordinary, yes. Uninspiring, alas, also yes. Commonplace and hackneyed, of course. But none of these attributes makes them *normal;* they are merely evidence of the unimaginative, unthinking use of a device. They can be more.

If you have something worthwhile to say or something that deserves emphasis, you can find verbal language to express it vividly, colorfully, memorably. You can achieve this by using interesting words, poetic imagery, verbose circumlocutions, bombast, startling twists, exaggeration, even distortions. Our visual vocabulary is nearly as rich as is the verbal. To demonstrate its capacity for subtlety of expression, here follows a group of illustrations presented in case study format that take what appears at first glance to be the normal and transform it into something slightly different. Perhaps you can find a technique or two that might be relevant to your needs when the situation arises.

Here are three simple curves whose data are identical, yet whose interpretations are quite different.

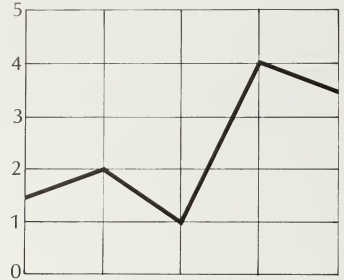
This one is neutral. The vertical and horizontal scales are equal, so the rectangle of the field is a peculiar one — a square. It exaggerates in neither direction, so the curve is shown as an "opinionless" statement.

This one says that the changes that have occurred are dramatic, rapid, sudden. The vertical scale has been exaggerated to make this interpretation possible.

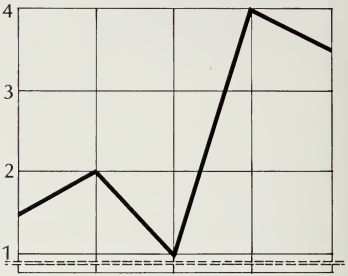
This one says that the changes that have occurred have been sluggish, slow, and flat — hardly worth mentioning.

Principle: Altering the scale of the chart's field alters the way information is perceived and interpreted.

Here are two more versions of the same data used in the preceding example.



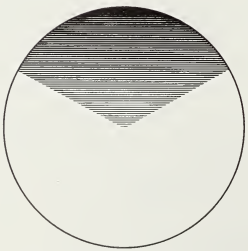
This shows the full range of indices on the vertical scale; that's why the curve is comparatively flat.



This plots the same data, but only in part. The height of the vertical scale has remained constant, but the top segment of the vertical scale has been lopped off, and the lower segment "broken." The overall shape of the diagram is the same, but the change in scale allows the curve to occupy a larger area, making its motion seem that much more dramatic.

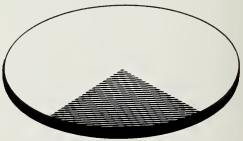
Principle: Manipulate the scales to expand or contract the image within a given area.

Here are three simple pies whose data are identical, yet whose interpretations are quite different.



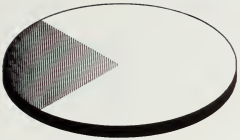
This is one seen head-on. It is accurate, straightforward — the very paradigm of a pie.

This one says that the gray wedge is unimportant because it is so far away from you, hidden away, back at the far side.

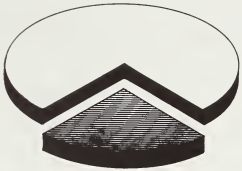


This one suggests that the gray wedge is inescapable, up front, forced into the viewer's consciousness.

Principle: The closer an element appears to be to the viewer, the more strongly it intrudes on his or her consciousness. Therefore, its importance seems greater (though in strict statistical terms, it may well be depicted accurately and correctly).

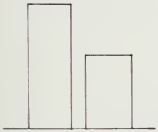


If you really want to hide that 25 percent wedge, show it as the narrow end of an ellipse . . .



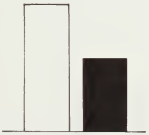
. . . and if you want it to come out and hit the viewer squarely between the eyes, let it poke out as a separate wedge in the foreground.

Here are four pairs of columns. The statistical facts in all are identical. The effects, however, differ.

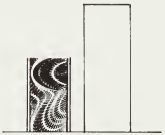


Both columns have been rendered as simple, pale, straightforward outlines. No opinion is reported; just the dry facts are shown.

The left-hand column of this pair has been blacked in; since blackness looks more positive and stronger, it draws the eye to itself. The result of such contrast is that the black element looks even bigger than it is, as though it dwarfs its neighbor.



Here the right-hand column has been blacked in. Although it is smaller, the right-hand column is now the dominant element. The disparity in size is hardly noticeable because the camouflage of apparent "importance" (read "blackness") is doing its work.

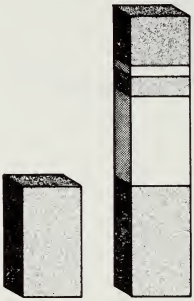


The positions have been switched. The smaller column has been placed "ahead of" (i.e., to the left of) the larger one. This gives it pride of place. Its implied importance is so enhanced by its flamboyant texture that the larger column has been robbed of its importance and is now reduced to a secondary, supporting role.

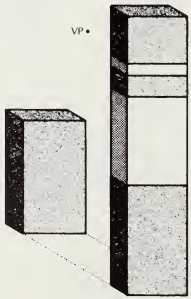
Principle: *Color influences our perception of elements in a chart by making them appear larger or smaller, closer to the viewer or farther back.* There are no rules of thumb about these characteristics, for they depend on the size, shape, proportion, and relationship that each piece of color may take to its neighbors. The painter Josef Albers spent a lifetime studying the recessive and advancing characteristics of different hues — in abstract terms. Just because a color is bright doesn't necessarily make it appear more important or closer to you; darkness is only perceived as such when contrasted with paleness; cheerful, bright colors can be taken as garish or crude by viewers who are used to sophisticated, restrained palettes. The most difficult problem of all is that you will never be quite sure how any color will actually look until it has been printed on your stock. Color, therefore, is a tricky material, but that should not deter you from experimenting with it, when it is available. Remember, however, that the four tricks shown here were accomplished using ordinary black and white.

Here are the same data shown four ways.

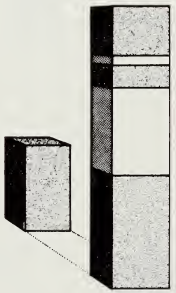
This simple, factual statement compares two columns, each having two gray blocks of equal height.



The columns have been given a third dimension; the small block at left can be perceived as being larger at first glance, because it has the added "top." That is, admittedly, rather a tenuous possibility, but fleeting impressions — mistaken though they be — are often the basis for wrong conclusions.



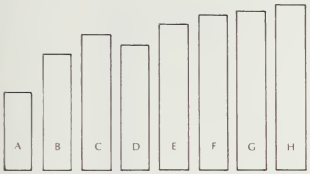
There is no question that the column in back is larger than its corresponding gray block in the right-hand column — except that it isn't. It just looks that way, because we expect objects that appear to be in perspective to be smaller; if they appear to be the same size as objects in the foreground, they are deemed to be bigger. This figure is not drawn in true perspective, but rather at a 30° angle.



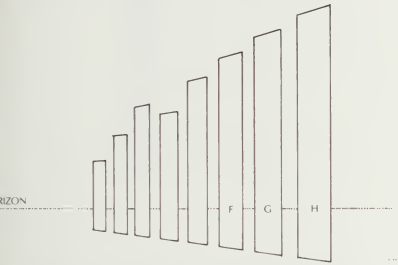
These two columns are drawn in true perspective, the vanishing point indicated at left. This is a much more credible rendering than the previous version drawn at 30°, because the columns "sit" on their ground much more comfortably. However, although the statistics are correct in terms of the way the figure was constructed, the column in back is clearly much smaller than the equivalent gray area in front.

Principle: The third dimension is another technique to use to your ends, because it adds a dimension of possibilities impossible with figures that are restricted to flat surfaces.

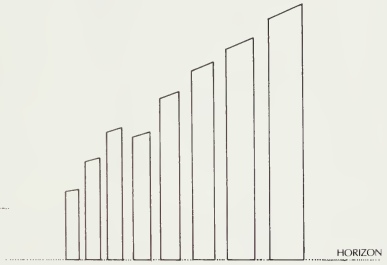
Here are five renditions of the same facts; they are plotted accurately on different grids. The grids are, in fact, absolutely accurate and are based on identical data and distances. However, the diagrams are drawn in perspective at various angles to, but at the same distance from, the vanishing point. The relationship of the viewer's imaginary eye level to the drawing makes a great deal of difference to the final effect.



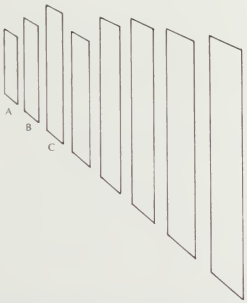
The viewer's first impression of this standard, head-on rendering is that the column lengths differ insignificantly in height.



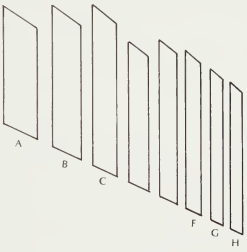
Here are the same facts plotted on a perspective grid, with the horizon line (shown dotted) part way up the columns. Columns F, G, and H loom much larger and dominate through their exaggerated size, because they appear to be "nearer" the viewer.



Here the horizon line has been dropped to correspond with the base of the columns. In all other respects the drawing is identical to the previous version, yet the growth of the columns at right is no less than spectacular.



The horizon is now far above the figure (we appear to be floating in the air, looking down at the columns). The severe angle of the baseline is such that the tops of the right-hand columns appear to be at the same level as the ones at left. Our first impression is that no growth at all has occurred, until we start studying the column lengths —but by then it's too late; we're already prejudiced.

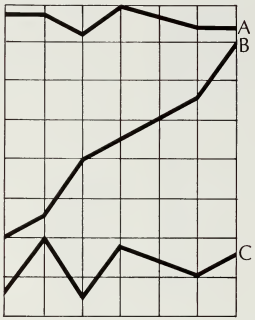


The entire figure has been plotted from the other side, with the short, left-hand columns (A, B, C) closest to the viewer. Furthermore, the horizon is far below the figure's baseline —we seem to be looking up at it. The diminution of the right-hand columns (F, G, H) is remarkable.

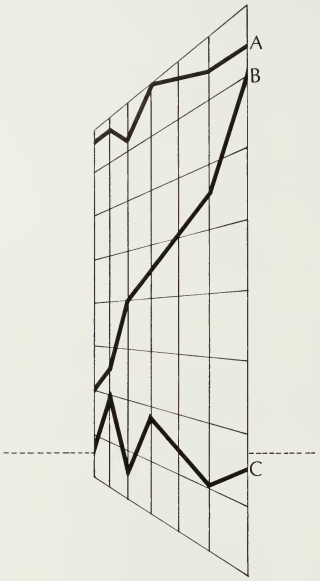
HORIZON

Principle: Perspective can be used to alter the appearance of the data otherwise accurately represented.

Here are two curve charts showing identical data but communicating quite different conclusions.



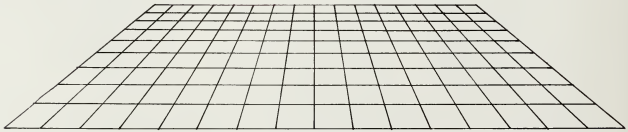
This straight-on view shows three curves: Line A decreases by a quarter of a square from beginning to end—not very much, but nevertheless a definite and plottable amount. Line B rises steeply. Line C increases considerably from start to finish, although it fluctuates a lot in the process.



Here the same data are plotted on a field in perspective. Line A (which actually decreases) appears to rise; its end is so much higher up on the page than its beginning. It is not, in fact, higher up on the chart, but our first impression is that the line travels upward, and our conclusion is that A increases.

Line B appears to rocket upward at a much steeper angle and thus faster rate than in the head-on view.

The end of line C is considerably lower down on the page than its beginning. The true horizontal has been indicated by the dotted line to show just how much difference perspective actually makes. Since there are all those ups and downs in line C between its start and end, the viewer is hardly conscious of the grid's angle. The upshot is that, instead of showing considerable increase, the curve suggests overall decrease.

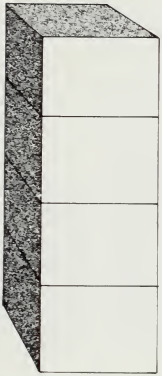


Consider how useful this format might be to flatten down some of those higher mountain peaks and build up the lower reaches, so that the overall impression is much less jagged than it is when seen head-on.

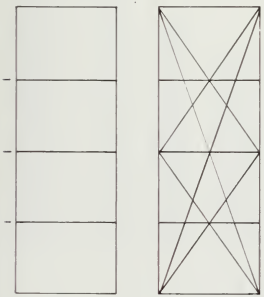
You could exaggerate that impression still further by changing the scale to a very wide one for the horizontal axis and a very short one for the vertical units in order to compress the information into a very wide, squat rectangle.

Principle: Choose a grid in strong perspective, then impose the charted data on those parts of it that will bring the ends of the curves into unexpected relationships with their beginnings, if such manipulation is advantageous to your story.

These columns represent the same data. One is seen from a normal viewpoint; the other is looked down at from the sky. The difference in proportions is striking.

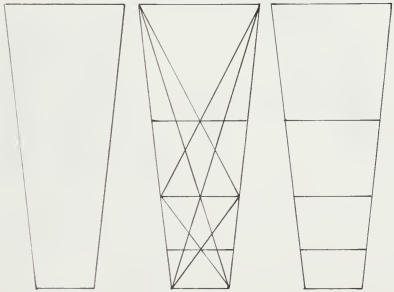


In this version both sides are straight, vertical lines (draw the surface in front first, add the three-dimensional side later). The height of the column can be divided into four equal segments by measuring or by geometrical drafting. Shown below are the two options: the measured one at left, the drafted one at right. The splitting of the rectangle into halves is done by drawing diagonals; where they cross is the halfway point. The procedure is repeated for quartering and can be repeated as needed for further halving (see page 190).



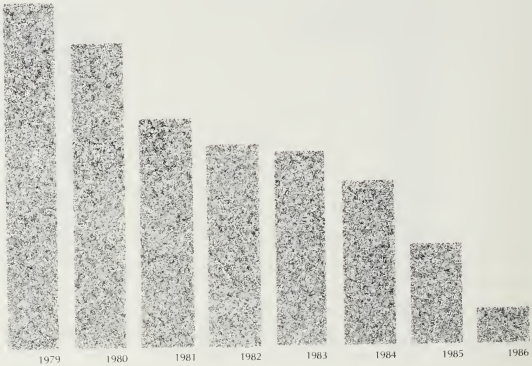
This is as accurate a version of the facts as the one shown at left. But how is it possible that the top quarter appears so much larger than the quarter at the foot of the column? First, you draw the rectangle of the front face, the way you would like to see it — it is an arbitrary shape, the same way that the head-on view is arbitrary in its proportions. How it is broken into its four equal quarters is not arbitrary — it must be accurate. You use precisely the same technique in this "rectangle" as you would were the rectangle vertical-sided like the one at left: Describe the diagonals, split the figure at the crossing, repeat the procedure for the subsequent halvings.

The greater the disparity between the width of the top and the bottom, the more exaggerated the difference seems between the segment near the top and the one near the foot of the column. Add the third dimension by joining the edges to a vanishing point (placed wherever it looks right).

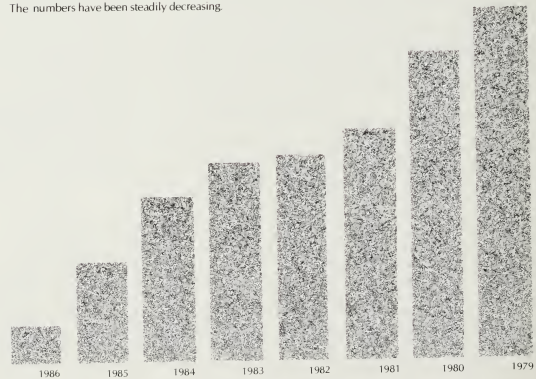


Principle: Foreshortening brings the part closest to the viewer into greater focus while reducing in importance the parts that are apparently farthest away.

Here are two column charts whose data are identical, yet whose interpretations (at first glance) are totally opposed.



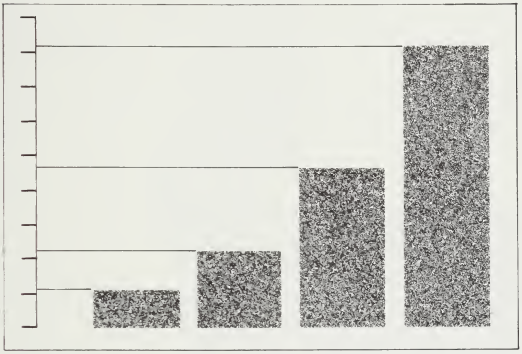
The numbers have been steadily decreasing.



The numbers are going up! But wait—if you bother to look at the dates, you'll realize that they are plotted backwards.

Principle: We read from left to right and interpret changes as occurring in sequence in the same direction. We take it for granted that the chart is set up that way and often neglect to read the small print at the base of the columns.

Here are two versions of the same facts, one shown as a normal column chart, the other as pictogram. Their heights correspond but they certainly don't look the same.

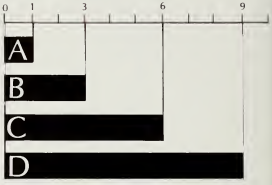


Simple columns describe the facts clearly.

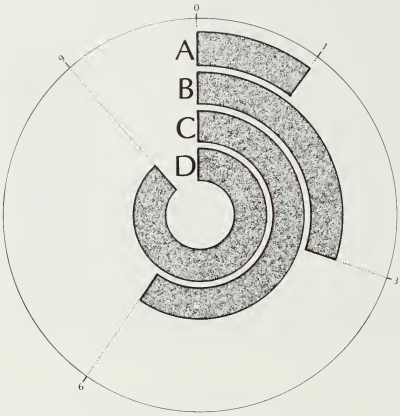
The same facts have been illustrated here by pictures instead of columns. The pictures are of equivalent heights, to make the statistics accurate. But as size increases in one direction (in height), it also increases in all other directions. The result is that, instead of comparing heights, the viewer compares areas — and the shopping cart on the right surely makes the biggest impression.

Principle: Converting data into pictures is fraught with danger, if accuracy of impression is desired.

These three charts show identical data, but they most certainly don't report them in the same tone of voice, do they?

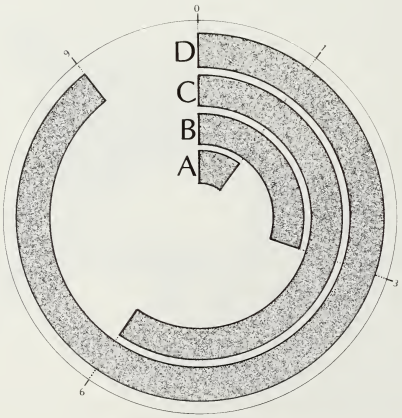


This straightforward bar chart presentation of four segments (A, B, C, D) of varying lengths (1, 3, 6, and 9 units) is absolutely normal and direct.



Here the same bars have been drawn around a circle, which has been divided into ten units. The bars have been placed in the same order in which they appear in the diagram above: A is on the top, D is on the bottom of the row. They all start at 0.

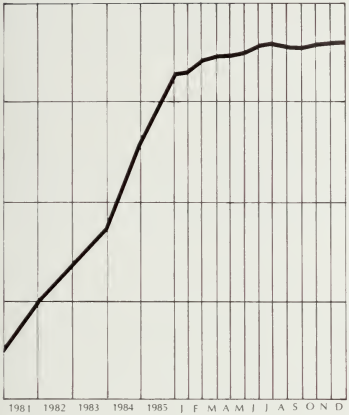
Because the outermost bar is farthest away from the center of the circle, its length is much exaggerated; because bar D is closest to the center of the circle, its length appears to have been reduced. In the original diagram, bar A is nine times shorter than bar D (and if you measure in angles, the fact remains perfectly correct in this diagram also). But bar D is here reduced to an insignificant vermiform squiggle, and the pride of place is preempted by bars B and C.



This diagram uses a technique identical to the preceding one, but with one change: The order of the bars has been reversed, so that bar A (the short one) is now placed near the center of the circle, and bar D (the long one) runs alongside the outer circumference. Mathematically the angles are as correct as they were in the previous renditions, but bar D has suddenly been made to appear much longer.

Principle: In a circle, the farther away from the center you go, the longer the circumference grows. In order to take advantage of this characteristic, you need only decide which facts you wish to inflate and which to deflate and place them in the circle accordingly.

Here are three graphic ruses.



Camouflage shortcomings behind lots of details. The rate of improvement in the last year was not up to those of previous years. So extra width was given to the last year, each month was shown by itself, and the focus shifts to the dark area of the diagram. Within the year itself, the message is one of steady, sustained growth, which looks much more readily acceptable than a sudden leveling off, which is what would have been visible were the last year shown the same way as all the preceding years.

The negative area (the part below the 0 line) is shaded gray. The contrast between the black line of the curve and the gray background is much less intense than that between the black line and the white background. The eye automatically travels to bright areas, those that are crisp and sharply contrasted. That's why the upper half (the "positive" part) will be seen and noted and the lower half (the "negative" part) partially ignored.

Make all your column tops look like arrowheads. Can the idea of everything going up be expressed more positively?

Principle: Accentuate the positive.

■ To make charts, graphs, and diagrams, you'll need time, money, and patience (these were discussed in Chapter 1). Now let's get down to practical matters: You'll also need two sets of prerequisites, without which diagram making is nigh on impossible. The process of turning words and data into visual expression is hard enough without your having to struggle with the mechanics involved. That is why the first prerequisite is the right physical conditions, and the second is the right materials. If you have the proper setup and the necessary wherewithal, the problems will seem less daunting.

Prerequisite 1: the right physical conditions

The kind of clear thinking you'll have to do requires concentration. That's why you must have a work area where you can be relatively undisturbed. It is much too easy to make mistakes in producing charts, for you are translating from one language (the mathematical/logical one) into another (the visual/graphic one). Plotting numbers correctly the *first* time is quite an intellectual exercise, so you must be able to shut the door on interruptions.

The tabletop must be ample so that you can spread your work out and see it all at one glance. You have to coordinate numerous factors from several sources, and you won't be able to keep that material straight if you're working on top of piles of accumulated memos, booklets, other charts, outdated versions, rival publications, reference books, and, perhaps, a copy of this manual! The neater your surroundings and the cleaner the desk top, the faster your job will be accomplished—and the neater it is likely to be. Besides, you'll take greater joy in working because you won't be struggling with the circumstances. As a result, you'll put more imagination and ambition into each image, and your charts will be more communicative as a result.

To produce precise graphics without strain, your space must be well lighted. Charts have to be exact. Making them is an exacting task. You should not have to battle eyestrain along with any other difficulties that may arise.

And, while on the subject of physical comfort, you must have easy access to water, so you can wash your hands, and your drafting tools, often. The cleaner they are, the crisper the final result will be—and the easier it will be to produce.

Prerequisite 2: the right materials

There are essentially two sets of materials you'll need: one for doing the rough, conceptual sketches, the other for producing the finished diagrams. The first is common to all diagram making; the second depends on the particular type of charts you're making—whether they are to be reproduced by printed media (and, if so, whether they are single color or multicolor), whether they are for presentation by projection (35mm slides or overheads), or whether they are produced by and for electronic means.

The first set, for rough concepts, consists of the simplest graphic materials: backs of envelopes, napkins at the lunch table, even a cuff may be ideal for scribbling on. At this stage, the idea—based on facts to be charted and their meaning—is most important. Defining that idea is, in fact, an editing process. It is more verbal than visual at this stage, but it is an essential stage to pass through, for only in so doing can you, as chartmaker, determine your communication goal. Every chart ought to have its particular purpose. This is the stage in which the verbally articulated purpose and the

visually conceived graphics are merged. All you need is enough material to make notes so you don't forget the decisions you reached; these include paper (graph paper is probably most useful because it offers an accuracy of its own), pencils (black and red), and anything else personal preference dictates.

The second set, for doing the finished work, depends on the kind of presentation you have to make.

1. *For meetings with just a few people:* Perhaps charts done on boards that can be mounted on an easel are all that's needed. Your materials should be in scale with that need — in other words, big: 20"×30" illustration boards, enormous drafting boards with unwieldy T squares and 16" triangles, light pencils with which to draw the guidelines (so they won't show), and lots of tapes of various widths and colors to cover those lines you do want to become dramatically visible. You can buy a tremendous variety of these materials in all sorts of patterns to produce any kind of result you wish, from the gaudiest to the most elegant; there are even tapes that turn around curves. There is also an unlimited range of rub-off or stick-on lettering with which to make the words. Obviously, this kind of "studio" has little in common with one in which charts are made.

2. *For reproduction by electrostatic printing:* Based on an 8½"×11" paper size (though legal size 8½"×14" is also often available), this offers essentially a one-color, line work reproduction capacity. Of course you can attach tints (or screens) to the artwork to make areas different shades of gray. And you can get remarkably good color reproduction very inexpensively on some machines. But those are embellishments that have to be used with care, depending on the capacity of the machinery to reproduce them well. Furthermore, the finish of the publication should be appropriate to the audience and the publishing purposes of each piece. An annual report destined to impress venture capital investors ought not to be run off on the basement copying machine. A notice about the annual company picnic, on the other hand, does not warrant eight-color sheet-fed presses and 100 lb. cast-coated cover stock. Technology, price, availability, scheduling, paper supply, and the audience's expectations — all play a part in influencing what you do and how you do it.

To produce artwork in tune with the requirements of this reproduction process, you need a drafting board with its normal accoutrements — T square (or equivalent sliding bar), triangles, French curves, templates, drafting instruments, pens, compasses, and a whole catalog's worth of other art supplies. The initial cost is not inconsiderable, but these things can last a lifetime if they are cared for properly. (That's why efficient and convenient storage space for these things is essential.) You also need graph paper, which makes it easy to plot the facts accurately and which is available in all sorts of scales and configurations. It also comes in "nonreproducing blue," a color that does not pick up in the reproduction process, allowing you to choose and ink in only those lines that need to show in the final print.

For the 8½"×11" page, your artwork will most probably be made at the same size you wish it to appear when printed. You can, of course, make it larger and reduce it photographically by the photostatic process (it is still called that even though it is being rapidly replaced by a direct-positive, "DP," process that produces a "PMT," or photomechanical transfer, which avoids the negative-making step demanded by the true photostat). You can increase or decrease the size of your artwork at will to make it fit the page size. But, to keep the look of the charts consistent, the lettering ought to be the same size on all of them. That's why you should keep lettering to the last, just before reproducing. If you are working "same size," without reducing or enlarging the original artwork, it is unlikely that you will need any type larger than 18 point, or smaller than 10 point.

3. *For full-color reproduction in ads, magazines, annual reports, and the like:* Here you're getting into highly sophisticated art department setups that simply cannot be summarized here because the variety of materials and techniques is so wide. If you are involved with full-color reproduction already, you know what is needed. If, on the other hand, you have to direct or buy such a service, you should rely on your supplier to supply you with what is needed, both in terms of know-how and materials. In the unlikely event that you need to set up your own production facility for such sophisticated output, it is even more advisable to seek experienced help from the outside.

4. *For electronic generation and dissemination:* Available options in this area are so wide and, at the same time, so specialized that it is impossible to generalize about them. Each combination of hardware and software has its own appropriate materials, printers, and input and output requirements.

5. *For presentation as 35mm slides or overheads:* The original diagrams have to be drawn as artwork in the normal manner to proportions that will fit the method and materials to be used in their showing. (These are defined a little later in this chapter.) Artwork to be photographed for 35mm slides must be finished art, with the colors in place. Essentially, the process is the same as that used to create large charts for presentation on easels, except that you can work on a much smaller scale to begin with. Here, again, the range of materials available is staggering; anything you can possibly imagine is available: matte or glossy, black and white or in rainbow hues, rub-off or adhesive, cutout, stenciled, preprinted and ready for assembly. You can find symbols, lettering, ruled lines, borders, tapes, corners—marks of all kinds. Visit your art supply store; it will be difficult not to overspend. Interestingly, though, the more materials you have at hand when you start chartmaking, the richer and more interesting the result will be, for your ideas will become broader, and fresh solutions will suggest themselves because the means for accomplishing them are at hand.

35mm slides can also be produced in two separate steps. The first step is to make a black-and-white master or "key" drawing. The master is then photographed as a negative that is used as a base onto which transparent color gels are stripped. The colors only show in those parts of the negative that are transparent because the black part of the negative hides the rest. Manipulating negative and positive film with the superimposed color areas becomes a very creative technique for splashy color effects of all kinds.

Overheads or viewgraphs have a totally different set of requirements, for their inherent possibilities include something no other technique has: sequential presentation by means of overlays added to the original artwork, as well as the possibility of making drawings during the presentation. The base figure, then, can be a quite simple black-and-white drawing reproduced on film by xerography. It is shown as the first step, and transparent color areas can be superimposed on it as the lecture progresses. All sorts of colored gels or transparent color markers can be added to the arsenal of graphic weapons with which to launch and strengthen your message.

Given the materials appropriate to your needs, and having set up the physical conditions most conducive to undisturbed work, you now face the problem of actually starting the work. A few pointers to help you on your way follow. They are practical tips based on experience, and their purpose is to persuade you that making interesting-looking diagrams is not a difficult process to be turned over to specialists. They, too, had to start at the elementary stages. It is a matter of desire coupled with practice, and anyone can attempt it. Most important is this insight: The art of diagram making looks difficult, but it is not difficult at all if you (1) know what you are trying to say, and (2) realize that you proceed one small step at a time, building the figure from fact to fact. You'll be amazed at the results you quickly achieve if you give it a concerted effort.

To draw lines

No matter what physical tool you may use—be it pencil, ruling pen with ink, drafting pen, ready-made tape, or other drawing instrument—you must decide on a set of weights (thicknesses) and use them consistently. That consistency ties all the diagrams together and gives them a professional character and the right look.

How do you make the choice? Arbitrarily: What works right and looks right is probably correct. Remember that the bolder the lines are, the more they intrude on the viewer's consciousness. Therefore, you need a hierarchy of thicknesses that will reflect the degree of intrusion or importance that each line deserves to have. Background grids are merely background, so they ought to be drawn in a lighter, thinner, less obtrusive line; since curves convey the meaning of the chart, they ought to be boldest. Obviously, there are cases where this "logic" is inappropriate. The point is not the thickness you use in each case, but the consistency of the application in a variety of cases.

A practical point to bear in mind is this: Often, when you are making a series of diagrams, some need to be reduced and others enlarged a bit to make them fit the space or to make their overall sizes consistent. Too often it is the final drawing rather than the prefinal one that is altered in size, and even though the final drawings may have been using line work of consistent weight, the degree of enlargement or reduction changes line thicknesses. To avoid a result that looks shoddy, be sure that all finished drawings are drawn to the same scale.

A second problem in all chartmaking is the need for precise draftsmanship in rendering corners. Where two or more lines intersect, there should be a simple, clean meeting without crossing, without leaving a gap, and without blobs of ink that fatten the ends of lines and create a puddle. If you use tapes or lines cut from adhesive acetate sheets, the solution to the problem is easier: Overlap the lines at the intersection, then cut them like a mitered joint at a 45° angle and remove the excess. The two lines will meet in "kiss register," to use a quaint printing term.

If the lines are drawn in ink, extend them beyond the crossing, then scrape away the excess ink with a blade after it has dried. (If it is still wet, the ink will smudge, and it is in the nature of smudges to be more difficult to remove than the original line!) You can also retouch the corners with white paint.

To add color and tints

The world we live in is full of color, yet chartmaking is essentially a black-and-white art. That's because the majority of diagrams are prepared for reproduction in single color for reports, scientific papers, newsletters, and the like. This doesn't mean that black and white is doomed to being dull or, conversely, that whenever you produce a chart in color you create excitement. In and of itself, color is just color; only intelligent utilization can make it exciting. By the same token, plain black can be rich and satisfying when used imaginatively.

Strong color, be it a hue or just black, should be applied to those elements of the diagram that deserve emphasis. It should highlight the message inherent in the chart by drawing the viewer's attention to it. If, at the same time, it embellishes the result a bit, so much the better. But remember that its purpose is not to create prettiness; rather, its function is to clarify communication.

As with all generalizations, there are exceptions. Indeed, there are some situations in which color—as a raw material—is an essential ingredient of the overall

impression. If that impression is important to the purpose of the document (as it is with annual reports, which must report the facts but do so as impressively as possible), then the functional use of color is skewed. It may or may not be utilized functionally within the charts, but it is being used functionally in the publication as a whole. But this represents a different level of thinking altogether.

What colors should you use? Some thoughts were expressed on page 179. Suffice it to say here that the means of reproduction will affect the preparations required for color usage. If the result is to be printed in four-color process, the choice of hues is unlimited. You simply prepare the artwork as colorfully as you wish, and it will be photographed (just as a landscape painting would be) for exact duplication. You may opt to draw the outlines of each color area on overlays—as so-called "keylines"—and the printer will strip in screens of the four process colors according to your specifications. The screens or "tints" you select are found on charts the printer will provide; they are normally expressed in terms of percentages of the four basic colors: yellow, red (magenta), blue (cyan), and black. 100 percent signifies solid ink, 0 percent means none, 10 percent is hardly visible, and 90 percent looks like a poorly printed solid. Most of your choices will be somewhere in between, if you choose to use each of the four colors by itself. The usefulness of four-color process, however, lies in the fact that you can print tints of the four on top of each other, thereby creating an unlimited spectrum of combinations. (Each color is applied to the paper from a roller bearing that particular color as the paper passes through the press.)

If you use black and a "second color," you will be printing on a two-color press that makes two impressions on the paper: one in black, the other in whatever other color of ink you choose, probably according to the PMS color system (the system that coordinates artists' colored materials with the printing industry's technology and fast becoming the standard for communication about color reproduction). It also means you will probably prepare the artwork already "color-separated"; that is, your black, base drawing will be done on illustration board, and the second color will be indicated on a tracing-paper overlay attached and keyed to the base drawing. In this case, too, you can vary the intensity of the color by specifying different tints or screens; furthermore, you can print the screen of one color on top of a screen of the other, thereby creating a third hue that often looks surprisingly different and enriches the appearance of the whole. Before you specify this kind of overprinting of colors, consult the appropriate swatch book guides or ask the printer; that way you'll avoid the wrong kind of surprises.

For colors reproduced on overheads, a whole different technology dictates different approaches. For the overheads you can buy adhesive-backed transparent film to cut out and adhere to your transparency. You can also paint in the colors with markers. That's perhaps obvious, but less obvious (and much more fun) is the effect you create by using black backgrounds for the charts to be projected. First of all, a white chart on a black background in a dark room is much more attention-getting than a black chart on a shiny white screen. Second, and more important, projected colors seen with a light source shining through them are brighter and more vivid than printed colors, no matter how well printed. Third, the black background gives you an opportunity to tape colored gels onto the back of the negative film without having the tape show. That way you have the brightest colors possible and they are seen against perfectly clean edges. You can use color over lettering, big areas or small areas, crudely or subtly, as you wish. Interestingly enough, the more color you use, the more valuable white becomes because it is brightest in contrast to the opaqued black; so if you really want to call the viewer's attention to something, leave it white in colorful surroundings. Making the black masters is easy. Simply have them shot as film negatives, or expose them onto thermo negative film in the xerographic process.

For 35mm slide presentations, the slides are either made from finished artwork (so

you can prepare it any way you wish because the photograph will show your product the way you made it) or they are made from artwork that has been prepared in exactly the same way as the process described for producing overheads. The only difference between them is that the overhead remains large, whereas the 35mm slide miniaturizes it for projection from a slide projector. There are also mechanically made and computer-generated chartmaking slide producers. Each has its own capabilities and merits. Find out what your supplier can best provide for you; color capability is one of the factors inherent in the systems.

If all you have is one color—black—don't despair. Not only can you add different screens that yield much tonal variety (all the charts in this book are just one color) but you can also enrich your results with patterns that not only yield a slightly different shade but also change the texture of the areas to which they are applied. As with so much else in this art production area, the sky's the limit as to the availability of screens of various patterns. A few catalogs from the many manufacturers of art supplies can start your search for patterns of just the right character.

A word of caution about using screens of black (or color) in combination with lettering: Watch out for legibility. A dark background makes black type superimposed upon it disappear, and pale backgrounds make white lettering dropped out from them disappear. Plan your color areas with the lettering in mind so they work together instead of against each other.

To do the lettering

Which should you use: typewriter type? typeset? strike-on? hand lettering? rub-off? cut-out and paste-on? stencil? engrossed calligraphy? machine-set on adhesive ribbon? The choice of any or all depends on circumstances, budget, time, availability of talent, availability of suppliers—and there are no rules. There is but one general comment that applies across the board: *Do the lettering better than you think it needs to be done.* Invest more effort, spend more money, take greater care, proofread more often than you think it is worth. Lettering cannot be done too well, and any effort spent on it is never wasted. It reflects on the workmanship, the value, and ultimately the credibility of the statistics and their message.

How big should the lettering be? All of it ought to be much larger than the minimum. That runs counter to the usual temptation to concentrate so much effort on the graphics that the words, generally considered to be a disturbing element that only spoils the picture, have to be minimized. The graphics exist to transmit information just as the words do. Both are integrally involved with each other; the one cannot exist without the other and still carry meaning to the audience. It is essential that the words share pride of place with the graphics. That simply means that they must be made easily legible. It also means that type has to be handled in such a way that its size and boldness (blackness or weight) reflect the relative importance of the words on the chart. Words that define scale should be smaller and paler than those that describe the subject of the most prominent graphic feature, for they are two different tones of voice: One is background, the other is foreground; one whispers, the other shouts.

Clearly, the title of a chart needs to be larger still, for it sets up the subject and purpose in the reader's mind. By the same token, the source of data can be tiny, for it is merely an acknowledgment and of minor importance to the understanding of the message. That is why a hierarchy of type sizes and weights ought to be worked out so it can be applied consistently throughout a series of charts within a document, presentation, book, magazine, whatever you have to produce.

Such a hierarchy must allow you to handle the title, subtitle, topic title, column headings, labels for graph elements, key labels, the body of tables or charts, key and legend names and subjects, scale indicators, footnotes, source identification—in short, everything that you can think of that can be solved beforehand. These decisions are much too important to be left to circumstances while production is going on and far too critical to amend in an *ad hoc* kind of way as convenience dictates. The impression charts make as a group is greater than the sum of their individual parts; their consistency (or lack thereof) reflects on the chartmaker's professionalism, expertise, caring, and dependability. So, knowing that the lettering will have to be spec'd sooner or later, don't leave it to the end; integrate it into the styling of the graphics from the very start. If you do, you'll allow the requisite space for every conceivable type element and you won't have to squeeze them in later. It is that kind of disaster you avoid by thinking ahead.

What typeface is best? Alas, there is no such standard as "the best." There are three criteria for choice: (1) availability, (2) legibility, and (3) appropriateness.

1. *Availability.* What your suppliers can supply, what your budget can stand, what your talent can produce—the answers to these questions will determine your range of choices. Study your options and select the most expensive because it is likely to produce the best results.

2. *Legibility.* Usually a function of size, legibility increases as lettering gets larger, but there is a danger in making it too big, for then it gets to be illegible again. How big should lettering be? That depends on circumstances and the way the product is viewed. If you must err, do so on the side of big.

3. *Appropriateness.* This trait of lettering is a function of subject matter, the context in which the final result will be viewed, and the audience for which it is destined. Here, again, there is no pat answer because there are just too many unknowns and variables. The only sensible generalization one can make is to use a sans serif face because it looks more technical and precise than most serif faces—and charts are supposed to look technical. Sans serif also has a more contemporary flavor. But even here there are variables, and if you want your charts to appear to be less technical, using a nontechnical-looking typeface is one of the choices you have.

If you really don't know what to do, the simplest answer is to make a collection of charts and graphs you like. Then take them to your local typesetter* who will be happy to help you identify various techniques and typefaces and will advise you according to your needs.

To subdivide a line into equal segments

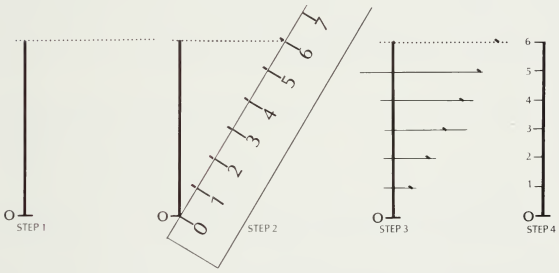
Assume that you have a vertical axis you want to divide into six units. The obvious way to do so is to measure it and then divide by six—except that you have to mark each segment into sixteenths of an inch (or perhaps "just a little bit over") and you get in a muddle with eighths. By the time you're finished, you're a nervous, quivering bundle surrounded by crumpled bits of paper testifying to your many false starts. How much easier it is to do it by geometry!

Draw your line to the desired length and then draw with nonreproducing blue or light pencil a line at right angles across the top. Next you need a ruler, any ruler, although one that is marked off in tenths of an inch or in centimeters or picas is better

*Although some printers still provide typesetting as a service, typesetting is a separate skill provided by parallel business organizations. "Printers" are not the same thing as "typesetters."

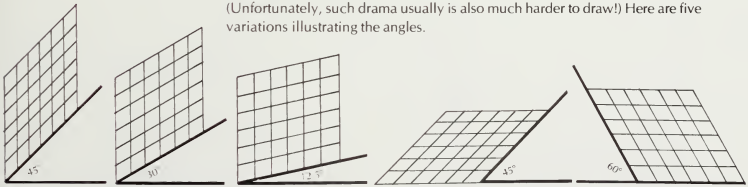
than the normal inch ruler because inches are divided into halves, quarters, and eighths and one tends to get confused by that. But you can even use that, if you remember to transform the quarter inches, for example, into individual units so that for this particular purpose 1¼" equals 5 units. (A metric scale, of course, eliminates the need for such mental gymnastics altogether.)

Now find the number of units into which you wish to break up your line on the ruler, making sure that the numbers on the ruler are a bit *longer* than your line is to be. Align the zero on the ruler with "O" on your line and, with that as center, swivel the ruler around until the desired number intersects the horizontal line you had drawn on the top of your vertical (step 2 in the diagram below). Now mark off the subdivisions with small dots on the paper; remove the ruler and draw horizontal lines from the dots to the vertical line you want to subdivide (step 3). Draw ticks, erase the lines, number the ticks —and it's done (step 4). To break the line up into more segments, swivel the ruler until the requisite number meets the horizontal line.

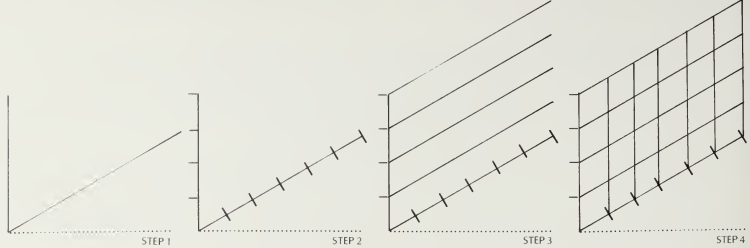


To draw a chart at an angle

Draw one side vertical or horizontal; make the other side at whatever angle you want it to be, using the standard angles provided by your drafting tools (probably 30°/60°, and 45° triangles) or using an adjustable triangle, which allows you to draw any angle you wish. Keep the angles conservatively shallow unless you want startling drama. (Unfortunately, such drama usually is also much harder to draw!) Here are five variations illustrating the angles.



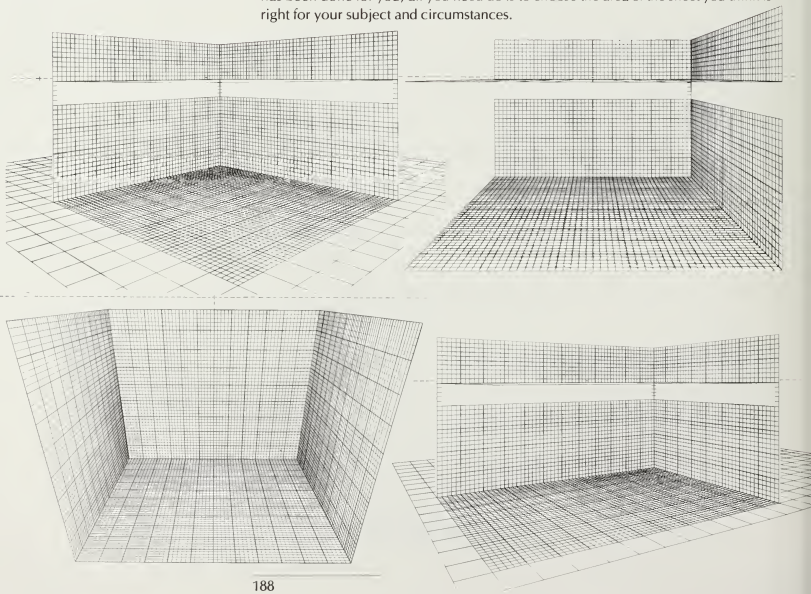
Once you have the two angles in place (step 1), you are ready to plot the grids. Divide the two lines into the requisite segments by measuring or by using the method described above. Then extend the lines across the field (step 2) to form the full

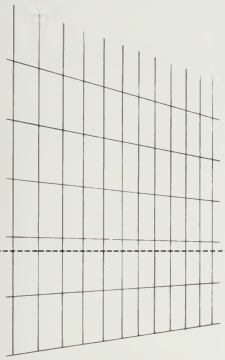


rectangle (step 3). The grids retain their equal spacing in both directions, since the only way in which these differ from a standard head-on view of the grid (where every line is either vertical or horizontal) is the angle at which one side is drawn.

To draw a chart in perspective

This is much more difficult to accomplish than just drawing a chart at an angle if you are starting from scratch, but you need not do that. You can use ready-made perspective sheets that are obtainable at any art supply store. With these the hard part has been done for you; all you need do is to choose the area of the sheet you think is right for your subject and circumstances.





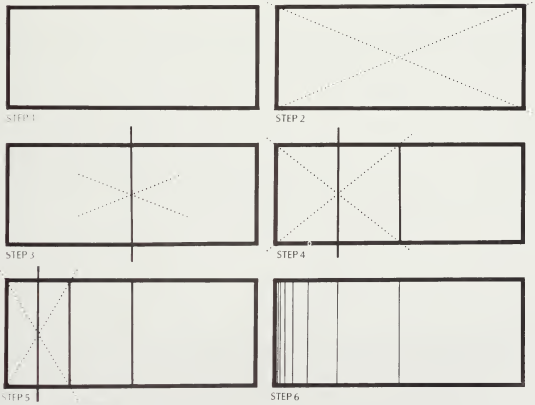
Place the sheet on the drawing board, tape it down in the corners, tack down a sheet of tracing paper over it to work on, and plot the diagram using the grid beneath as though it were graph paper. Its angles will be hard to copy accurately unless the vanishing point is nearby (it is always indicated on the perspective sheet). If you can get to it easily—if it isn't off the board—it is helpful to place a pin in the board at that point and use it as a pivot for drawing your lines. That is more accurate and faster than having to trace them.

Drawing blocks and objects for diagrams in perspective will probably require more effort. The method is described in detail on page 48.

The reason you need perspective grids isn't just that you have to get the lines in the right directions. It is also because the spacing of the lines varies as you see it in perspective: The farther away an object is from the viewer, the smaller it appears to be; thus, the lines of a grid that are supposed to be equidistant from each other (which is what makes them form a *grid*) have to be placed closer and closer together as you create the illusion of distance. That illusion is the result of reduced size; size reduction is the result of placing the grid lines closer together.

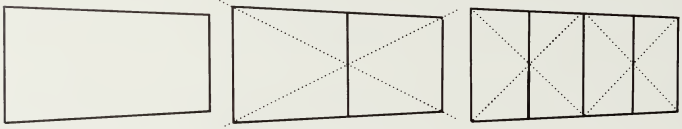
To halve, quarter, or eighth a rectangle

You want to bypass measuring or doing it mathematically, unless your shapes happen to be easy to measure. Here's how to do it by simple geometry: Draw the rectangle (step 1). Now draw in the two diagonals (step 2). Where they cross is the center of the rectangle. Draw a vertical line through that. You now have two equal halves (step 3). Now split the half into its halves by the same method, drawing the diagonals within the small rectangle (step 4), thereby producing four quarters in your original. Repeat the procedure, splitting each quarter into its two component halves and you create eighths . . . and so on ad infinitum (step 5).



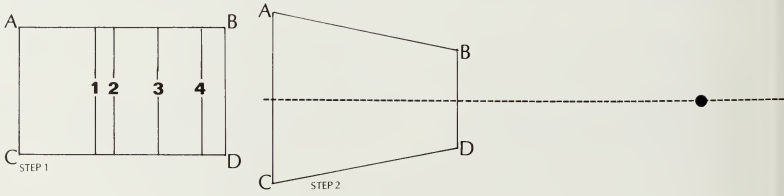
To halve, quarter, or eighth a rectangle in perspective

Do exactly the same as if the rectangle were not in perspective, following the procedure outlined in the preceding paragraph. You may get some startling results because the proportions seem a bit out of whack—but they are not. This is an accurate, geometrically correct method. You may be surprised at the apparently exaggerated differences between the half of a rectangle close to you and the half farther away, unless you are used to working this way. It's just because you haven't given the problem much thought—who has?—and have taken what you see for granted.

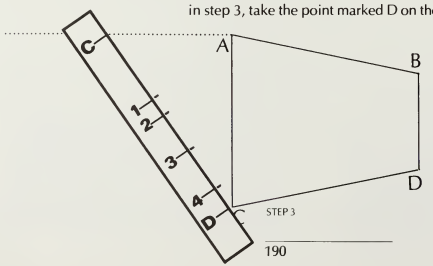


To split a rectangle in perspective into unequal parts

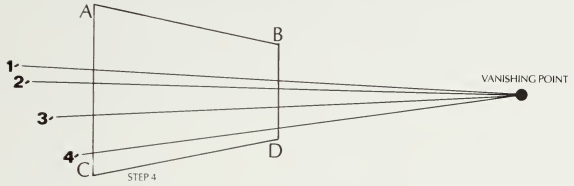
Plot the diagram first as a flat, normal rectangle, subdividing it accurately (step 1). Then draw the outline of the rectangle you want in perspective (step 2). How do you subdivide it so that the accuracy of the first is transferred to the second?



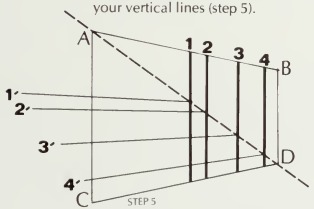
On the edge of a separate sheet of paper, mark the subdivisions in the first diagram—lines 1, 2, 3, and 4 on line CD—and prepare to transfer them onto the second. On that second diagram, draw a horizontal line through the top left corner (A). Now, as shown in step 3, take the point marked D on the line you copied onto your separate sheet of paper and place it on the C corner of the second diagram. Using that point as a fulcrum, swivel the paper around until the C marked on the paper intersects the horizontal line you just drew from point A. Mark the points (1, 2, 3, 4) onto the new drawing, then throw out your extra bit of paper; it has done its work.



Now comes the hard part. Because your rectangle is in perspective, you can, by extending the top and bottom lines of the rectangle until they meet, locate the vanishing point (step 2). You then join the dots you just made (1, 2, 3, 4) to the vanishing point (step 4).



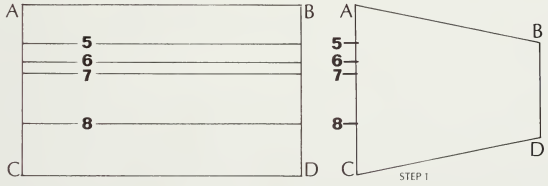
Having done that, now draw a diagonal through the rectangle from A to D. Wherever the diagonal intersects the lines connecting your four dots to the vanishing point, drop your vertical lines (step 5).



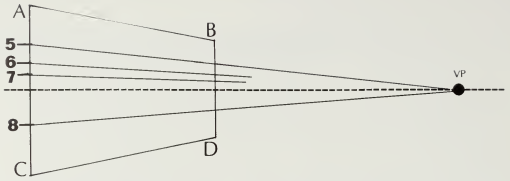
Draw them in and erase the construction lines or, much cleaner, trace the lines you want to show on a fresh sheet of tracing paper. You are left with a document that attests to your ability to take a flat drawing, turn it sideways, and have all the proportions remain correct.

To split a rectangle in perspective into horizontal layers

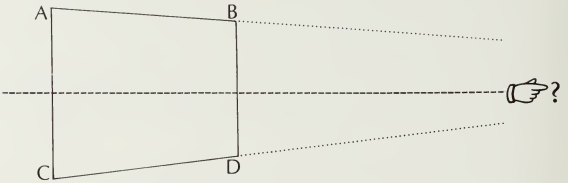
Let's assume that you have drawn the outline of your rectangle in perspective (step 1).



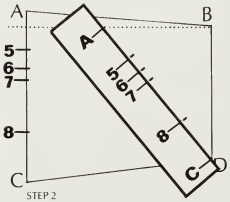
Next, you will need to scale off the vertical axis (AC), and that is done in the normal manner. But how do you scale off the opposite end (BD) so you're not doing it by guesswork? Were the vanishing point reachable, it would be simple, because all you



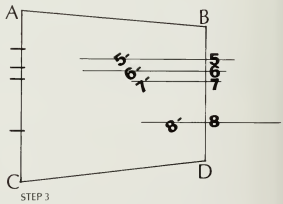
do is to join the known points (5,6 ,7 ,8) to the VP, passing through your vertical side along the way. But what do you do if the elusive vanishing point is somewhere in the next room?



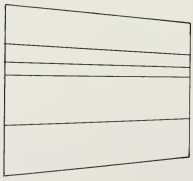
Quite simply, first you draw a horizontal line through point B on your diagram (step 2). Then you take a piece of paper, mark off on it the divisions shown on line AC (5,6, 7, 8). You then position point C on your paper on top of point D on the diagram and swivel until point A on your paper has intersected with the horizontal line you drew through point B (step 2). Mark off subdivisions 5 through 8, remove the piece of paper, and connect these points with your vertical (BD) by drawing horizontal lines to it (step 3). Then connect the points on line AC to those on line BD and there you are (step 4). (The technique is similar to that used for subdividing a rectangle into vertical segments because it uses the separate diagonal measuring-stick principle.)



STEP 2



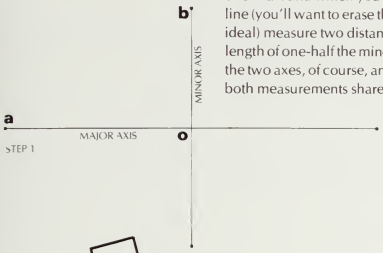
STEP 3

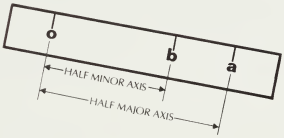


STEP 4

To draw an ellipse

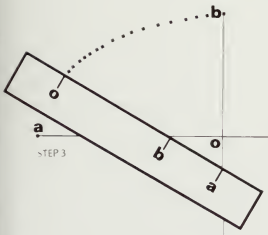
Establish the two axes—the "major," i.e., long one, and the "minor," i.e., short one—around which you want to draw an ellipse and draw them in precise but light line (you'll want to erase them later). On a card made of stiff stock (3"×5" file cards are ideal) measure two distances: the length of one-half of the major axis (AO) and the length of one-half the minor axis (BO). The letter O represents the center or crossing of the two axes, of course, and it is placed in the same position on your measuring card so both measurements share it as a common point (step 1).

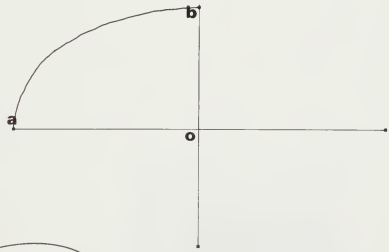


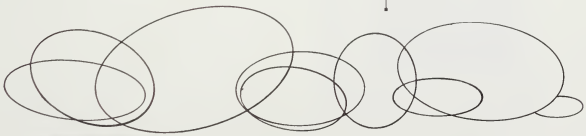


Now place the card on the axes in such a way that point B rides on the major axis, and point A rides on the minor axis; point O is somewhere out in the field (step 3). Wherever O is, place a dot, then swivel the card around, making sure that B remains in contact with the major axis and A with the minor axis, and make a dot wherever O happens to fall. As you move the card around, pivoting it about the two axes, you'll find O describing a beautiful, and correct, ellipse (step 3). The more points you plot, the easier it will be to join them and thus make a smooth curve. You need only plot one quarter of the whole ellipse, of course; you can then recopy it for the other three quarters by turning your paper around and over.

If this sounds too time-consuming or laborious, go out and buy templates and whip out ellipses any way your heart desires or patience can stand.



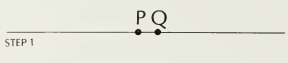




To draw a spiral

It is highly unlikely that you'll need to do this, but it is so easy that the technique is shown here just in case. Besides, now that you know how it is done, you may find an opportunity to make use of it.

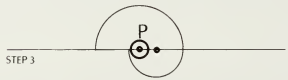
Draw a line in nonrepro blue or light pencil. Mark two points on the line (here labeled P and Q) at a distance from each other that is half the distance you want the lines of your finished spiral to be separated by (step 1).



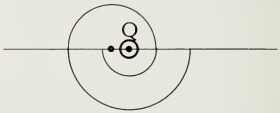
STEP 1

STEP 2

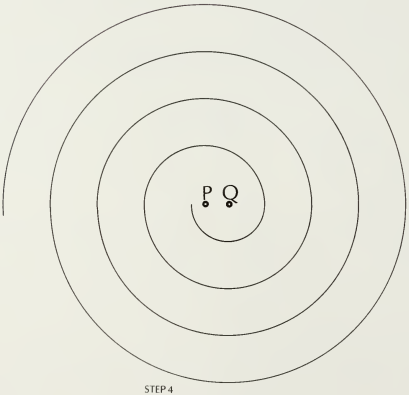
With the needle of your compasses centered on Q, describe a semicircle, touching the line at both ends (step 2). Now move the compass to P, and with P as center and a radius that picks up where the previous semicircle left off, describe a new semicircle



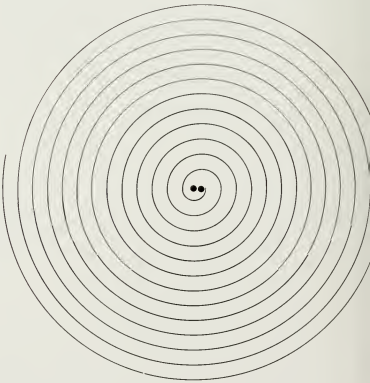
STEP 3



on the opposite side of the line (step 3). Now shift back to Q and enlarge the radius to pick up where the second semicircle ended. Repeat until the spiral is complete (step 4). Obviously, this requires care to ensure that the semicircles bump into each other without messy double lines, smudges, gaps, or other such visual blemishes that ruin the smoothness of the figure.



STEP 4



To prepare charts for 35mm slides

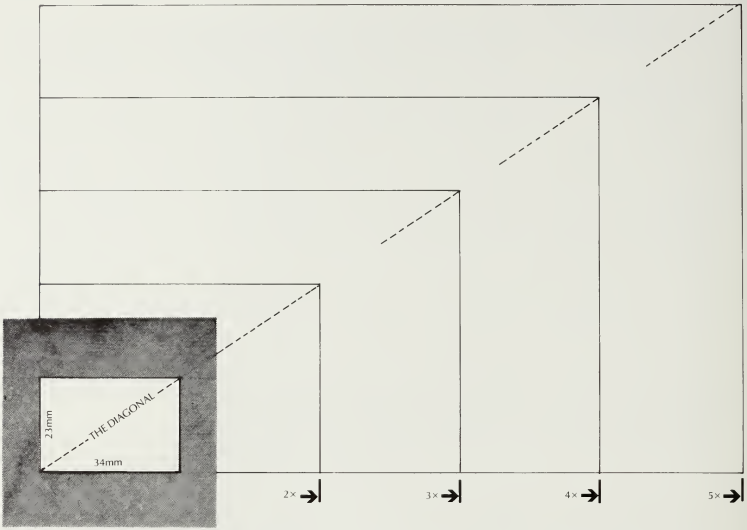
Making up artwork for slides can be done two basic ways: the normal hand-drawn/assembled way, in which the art is photographed as slides; or the automated, computer-generated way. Each has its advantages and disadvantages. In a nutshell, hand-drawn art is slow, expensive, and absolutely flexible, limited only by the chartmaker's ingenuity and imagination. Computer-generated charts are much faster, cheaper, and much more limited in their shapes (though often not in their coloration capacity). They are necessarily limited by the capability of the software that produces them—and obviously, the more sophisticated the software program, the more expensive it is and rare to its users. A further problem with mechanically produced art is that the resolution of the screens is regrettably coarse, resulting in lines that appear jagged and stepped instead of smooth and clean—especially those lines that do not follow the vertical/horizontal makeup of the screen's geometry, but that need to be shown at angles or as curves.

Charts for slide presentations have an undeniable advantage. They can be shown in sequence, and they can be flashed on the screen fast or kept in view for a long time. This variable rate of speed allows you the luxury of showing in sequence rather than combining all of the facts into a single image, as printed media demand. To make such a succession of slides you have to produce master art with the core information on it and then add further information to it by means of acetate overlays; each such step must be shot as a separate slide as the information is added to the master. What you are doing, of course, is making a filmstrip that can be projected quite rapidly and can communicate its message of development vividly.

Making the artwork for such progressive presentation obviously depends on the subject matter and materials at hand (see page 182 for some thoughts on the basics). All sorts of raw materials specifically designed for the purpose are available: paper of various colors, transparent acetates, color films and overlays that can be cut out or masked out, adhesive sheets that can be stuck on, both opaque and colored markers, as well as such technical aids as registration marks that will ensure that each overlay fits over the others to give an accurate and crisp result. What should you use of all these riches? The only sensible answer is: whatever you are confident enough to handle cleanly, precisely, and professionally. There are few things more depressing (and embarrassing) than amateurish presentations. What makes them amateurish? The fact that they cannot achieve the results their ambition seems to demand; the workmanship isn't up to par. There's nothing wrong with keeping it simple, if that's all you can produce *well*. It is the pretense at something that doesn't come off that leaves the wrong impression in the viewer's mind.

If you intend to make slides, it is essential that the artwork be of the right proportion to fit the shape comfortably and efficiently. The standardized image area is 23mm × 34mm. All graphics and lettering must remain within that rectangle, leaving a safety margin all around. Here is that rectangle.

The outer (cardboard or plastic) sleeve is shown here in gray. To help you work with this size, it has been shown enlarged two, three, four, and five times.



The techniques for enlarging a rectangle are extremely simple. There are two, one mathematical, the other geometric. The mathematical method is based on measuring and as such is obvious. Let's talk about the geometric technique because it is much more flexible.

First, you draw your basic rectangle (here, the slide itself). Then you draw a diagonal up toward the top right corner. By extending that diagonal farther, beyond the confines of the original rectangle, you can pinpoint the position of the upper right corner of any enlarged rectangle of the same proportions as the original. Where should it be? Anywhere you want it to be. You determine how wide the rectangle is to be and extend the horizontal line of your original rectangle to the requisite length. At that point you erect a vertical line. Where that vertical intersects your diagonal will be the correct top of your new rectangle. To enclose your rectangle, just draw a horizontal line to the left until it meets the vertical edge at far left that you must also extend to the new height. Obviously, you can work it the other way, too. First you decide on the height of the desired rectangle, extend its vertical lines and then, using the diagonal line method, determine its proportional width by drawing a diagonal downward from it. You can, equally, use the diagonal line method to reduce a large rectangle to smaller proportions. All you need is the original proportions, and the diagonal will guide you to a similar shape but of the size you wish it to be.

Can you, should you, turn the slide sideways and show it as a vertical? It can certainly be done, but bear in mind that it is usually better to establish a rhythm in a presentation to create expectations of scale and shape. It is unwise to jump indiscrimi-

nately from horizontal to vertical shapes; instead, keep one shape or the other as a consistent pattern and deviate from it only when you have material special enough to demand emphasis.

There are also superslides whose visible area is a square measuring 38mm × 38mm on the original slide and that fit into the standard 2" × 2" sleeve shape. A diagram ← of this slide size is shown here for comparison to the common 35mm slide.

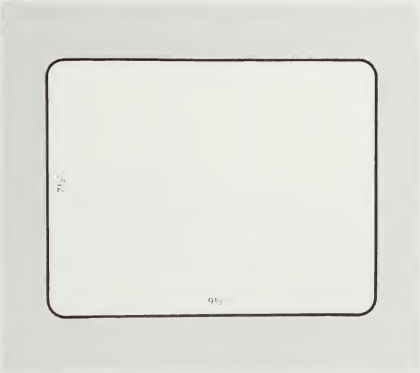
Planning slide presentations is a time-consuming, arduous task, not the least of which is inserting the slides into the trays. Stack loaders are available that allow you to assemble a handful of slides and show them without having to insert them individually in a carousel tray. Though very useful for fast run-throughs, it is easy to drop a fistful of slides and get them out of sequence; caution is advised. To help prevent upside-down images, why not mark one edge of the slide frame with an ink marker when they are in the correct configuration? You'll be able to see at a glance if there is one without the ink on it and catch it before the audience does.

To make charts for overhead projectors

Overhead projectors are very versatile and you can use them just like a school chalkboard. You can draw as you speak, or you can use them to project finished artwork.

The artwork is prepared in the normal manner on paper as black-and-white art. It is then transferred by electrostatic, xerographic means onto transparent film (PPC, or Plain Paper Copier, film).

The aperture for most overhead projectors measures 10" ×10" to accommodate both vertical and horizontal images. Most PPC film measures 8¼" ×11", although some comes a trifle smaller. If you place a sheet of film onto an aperture that is larger, you'll have a blindingly bright edge that cannot be covered up. It is therefore wise to place all transparencies into sleeves that are expressly made for that purpose. They measure 10½" ×12"—thus covering the projector's aperture comfortably. Their opening measures 7½" × 9½", so artwork should be proportioned to fit.

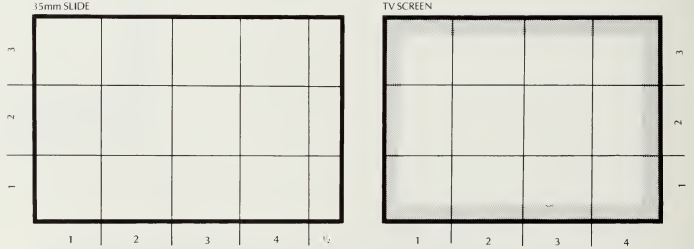


To prepare charts for television screens

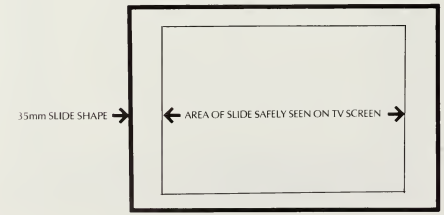
There is little to make this process any different from others except for one frustrating problem: The shape of the screen is not coordinated with any other. Therefore, if artwork is to be viewed on TV, cathode-ray tubes, most (though not all) monitors, or computer screens, it has to have chubbier proportions to make it fit right. Exacerbating the problem is the fact that the technology sometimes doesn't work as it should, and the outer edges of the image get lost off screen. In charts, those outer edges (the axes on graphs, for example) tend to contain crucial information that describes what the chart is about or what units it is broken into. So you have to keep well within the outermost limit to be sure your entire picture will be visible.

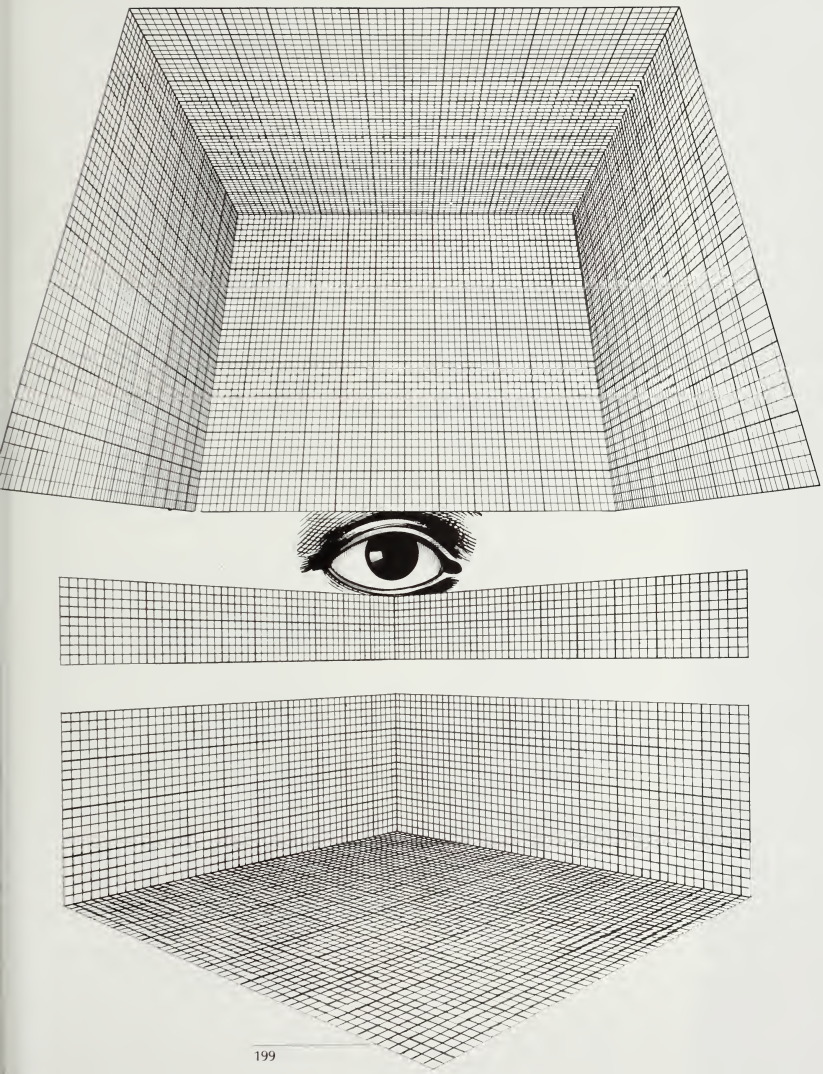
One other problem is that the degree of resolution of the screens varies (in proportion to their cost, of course). To ensure legibility under the coarsest circumstances, it is wise to make everything bigger, especially the lettering, than you would deem appropriate for printed media. Also, make it simpler; avoid as many diagonals and curves as possible (they get to look jagged and wiggly). Don't expect as much as you do of fine printed media; these are totally different technologies, and the artwork is not completely interchangeable.

The difference between the TV screen and a 35mm slide is this: The 35mm slide has a shape whose proportions are just about 3:4.5. The TV screen's proportion is 3:4. The diagram makes the difference clear.



The area around the TV frame (shown shaded) is the dangerous area that might disappear from view. The diagram below superimposes the outline of the "useful" area of the TV screen onto the outline of the 35mm slide. As you see, you have to sacrifice much more of each side than you do of the top or bottom to ensure visibility for your chart on screen.





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About the Author: Jan White has achieved fame as a lecturer, teacher, and award-winning designer who makes communication graphics easily accessible to designers and nondesigners alike. He brings the experience of designing hundreds of magazines, tabloids, newsletters, books, manuals, and other types of information literature to *Using Charts and Graphs*, as well as his other books.

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